FIREARM ANATOMY • BOOK I

The Thompson M1A1 Submachine Gun

David S. Findlay

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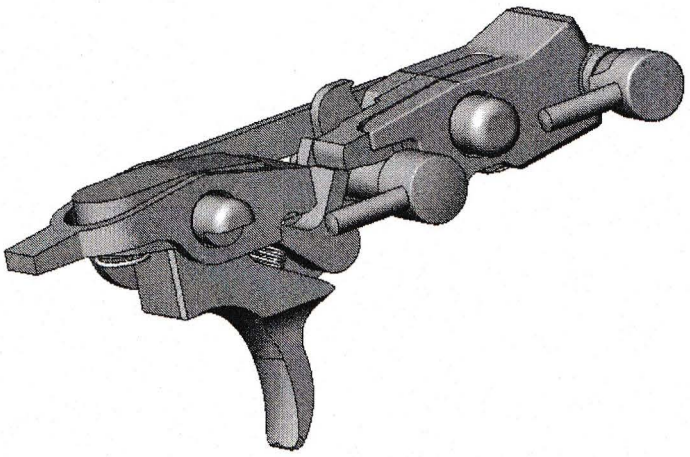

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Dedication

To my father, David Findlay,
fellow gun designer, mentor,
confidant, best friend, and Dad.

WARNING!

The legal possession of an automatic firearm is controlled by the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) division of the US Department of Justice. Proper application to ATF must be secured before an individual can own and operate this type of firearm. Severe penalties are authorized for violators of these laws.

The information enclosed in this book offers information for the academic study of firearms design and disclaims any responsibility or liability for the improper or illegal use of this information for the construction of an automatic firearm.

This manuscript has been reviewed by the Department of Defense for technical data as defined in the International Traffic In Arms Regulations (ITAR) and has been **approved** for public release. Export of this material is **not** restricted by the Arms Export Control Act and may be exported or transferred to non-U.S. persons without prior written approval from the U.S. Department of State. This approval for release does not imply Department of Defense endorsement or factual accuracy of the material.

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Preface

This book was written to generate people's interest in gun design.

The gun industry needs and is due for the next big breakthrough. Every 100 years seems to bring the next significant development in firearms technology. In the 1600's, the wheel lock was developed and heralded the first use of firearms. In the 1700's came the flintlock musket. In the 1800's came the percussion cap and, later in the century, the thin brass shell used to carry the powder, bullet, and primer was perfected. While the 20th century has seen the invention of liquid propellant, caseless ammunition, and the gyrojet, the thin brass shell has been hard to beat and is still the dominant way to feed ammunition to the firearms of today. We are due for the next advance, but from where will it come?

Gun design lends itself to one designer/engineer with a vision, many times helped by a team of draftsmen and model makers. Most of the truly successful gun designs of the past century were developed in this way. Sometimes these men were able to form companies based on the guns they devised. The following tables show the primary designers of successful military and commercial firearms.

Primary Designers of Successful Military Firearms

Successful Military Firearms	Primary Designer
AK-47 Assault Rifle	Mikhail Kalashnikov
Uzi Submachine Gun	Uziel Gal
M-16 Assault Rifle	Eugene Stoner
M1 Garand Semi-Automatic Rifle	John Garand
M1911 Pistol	John Browning
M2 Machine Gun	John Browning
BAR Light Machine Guns	John Browning
M1917 Machine Gun	John Browning
Maxim Machine Gun	Hiram Maxim

Primary Designers of Successful Commercial Firearms

Successful Commercial Firearms	Primary Designer
Remington M870 Pump Shotgun	L. Ray Crittendon, Phillip Haskell, Ellis Hailston, and G.E. Pinckney
Remington M1100 Semi-Automatic Shotgun	Wayne Leek
Winchester 1894 Lever-Action Rifle	John Browning
Colt Revolver	Samuel Colt

Hopefully this book will interest you in the simplicity and the hidden complexity that good gun designs exhibit and to prompt you to investigate the field of firearms design further.

Acknowledgments

I would like to acknowledge the people who shared their valuable time and expertise to comment on various parts of the book. These include Bob Johnson, a process engineer who worked with me at H&R 1871, and who loves to point out when I am too verbose or going off track with my thinking. Bob has always helped me be better than I am by myself. Many thanks need to go to Nancy Ovedovitz, my sister-in law, who did the cover and helped the book come to life. I would also like to thank my mother, Marie Findlay, who has corrected my wording since I wrote my first papers back in elementary school and who once again came through to help me with this effort.

I also want to thank my wife, Donna, who has put up with me working on this book off and on for many years. She has always been supportive. I also thank both of my sons, David and Michael, who have had to share the computer with me during much of this time. Many a night this book was a priority over their computer gaming time (but not their homework!).

Finally, I would like to thank my father, David Findlay, who, for many years, worked for Winchester Repeating Arms, then for Bellmore Johnson Tool Co., and finally for himself at Guilford Engineering Associates, being both a gun designer and a firearm product liability expert. My father has helped my understanding of firearms immensely and has been a helpful confidant and mentor in all my endeavors, working at Remington, Marlin/H&R 1871, and now at Smith and Wesson. He has always been my inspiration and guide.

From the National Archives and Record Administration
127-GW-856-88079
Marines cover the opening of an enemy pillbox on Tinian Island as they give the occupants the choice of surrender or going to their ancestors. July 1944. The individual in front has an M1A1 Thompson with the addition of a vertical fore grip.
The other individuals have M1 Carbines.

Chapter 1
The Thompson's Creation and Designers

No other gun has captured the imagination of the American public more than the Thompson Submachine gun. Used by gangsters, law enforcement, and thousands of G.I.'s and British "Tommies" during World War II, its shape is familiar and recognizable to many. Designed for World War I, it was lucky to make it to the Second World War, with the Great Depression in-between and no real commercial market for the gun. It was made and designed in an era of machined and cast components for firearms. Stampings and plastic moldings in guns were not a consideration like they would be a generation later or as they are used today. As is the case today, the development of a gun involves many phases. The Thompson's development history started with great expectations. It went through periods of great intensity, disillusionment, and then a rapid expansion of volume. This rewarded not its developers, but those not involved in its creation.

The Thompson was a vision of General John T. Thompson. As is the case with many design programs, and not just for firearms, there needs to be a man of vision, as a mentor and champion, to guide and push a successful project to completion. General Thompson was a man with a history of firearms development and manufacturing in the US Army and in private industry. General Thompson believed in the merits of automatic function for both pistols and rifles and thought designs incorporating automatic function should be the mainstay of the US Army. He was ahead of his time.

General Thompson was in a unique position to see the landscape of firearms development in the early 1900s due to his serving as Chief of Ordnance and the time he spent at the Springfield Armory and Rock Island Arsenal. He had the insight to recognize that the patent granted to John Blish in March 1915 (#1,131,319) might fit his vision for a new automatic rifle with its new type of locking mechanism. He contacted Blish and found him agreeable to the use of his design in exchange for a block of stock in a company that Thompson would form to pursue this design further. Thompson was not the man with the money though, and for that he was able to enlist the support of Thomas Ryan, whom he met through family acquaintances. Ryan bankrolled the formation of the Auto-Ordnance Corporation in the summer of 1916.

General Thompson now needed some employees to be his design team. In *The Gun that Made the Twenties Roar*, William J. Helmer said, "It was Thompson's policy to judge men primarily on their character and to place more importance on their talent and ambition than on their experience. He especially liked young men who were not set in their ways of doing things and who were motivated by a desire to advance themselves professionally. He emphasized the importance of the 'human factor' in engineering, of treating subordinates courteously and fairly and placing confidence in them."[1]

Helmer went on to say, "Thompson hired as chief engineer, Theodore H. Eickhoff, who was 30 years old and had been an assistant to Major Thompson. From 1909 to 1914, Eickhoff worked closely with Thompson, studying commercial and military rifles and testing Colt and Savage automatic pistols, which were then competing for adoption. It was Eickhoff's duty to witness tests, record the results, and make reports."[2]

Helmer also wrote: "George Goll, 27 years old, was Thompson's driver, but impressed Thompson as being a bright young man with a good deal of mechanical aptitude. Thompson asked him if he would like to learn small arms, working as a design assistant. Like Eickhoff, Goll accepted enthusiastically."[3]

"Most of the testing was done by Charles Tunks, the Auto-Ordnance 'tinkerer.' When Thompson sent Eickhoff to Cleveland on a permanent basis, he was told to hire a good 'gun tinkerer' to work the bugs out of new designs by trial and error. Eickhoff located and hired Tunks and he turned out to be ideal for the job. Patient and painstaking, 'he could stand there at a workbench for hours, filing and fiddling until he got something to work.' And getting things to work was Eickhoff's greatest headache."[4]

The most important man for the Thompson design team was Oscar Payne. "Payne was a 23-year-old self-taught draftsman and engineer who Thompson had met while at the Ordnance Department on patent business," author Helmer said.[5] When reviewing the patent history of the gun and digging into its story, it is apparent that Oscar Payne was the primary designer for the Thompson submachine gun.

What General Thompson had done was to form a multifunctional team with varying skill sets composed of young men who were all motivated. Remember, World War I was ongoing when this gun was in development, and it was intended to reach the battlefield of that war. This provided plenty of motivation for the team. The gun's relatively quick development at the beginning of the program can be attributed to these program members and the intensity of the program. When the war ended, that intensity let up, and the pace of the program changed.

Reviewing the gun's timeline illustrates that it took approximately three years from initial concept to a fully tested design capable of being manufactured in quantity. Today, a new gun program with approximately the same number of parts as the Thompson can last from two to four years with the same type of team, depending on the team members' experience, chemistry among the team members, and the design's complexity. The Thompson was designed in the age of the drafting board. It was a time when machine equipment was belt-driven from long leather belts running to ceiling-mounted drive shafts. The computer-aided design (CAD) software for modeling parts and sophisticated dynamic simulation software still have not managed to cut a firearm's development time down significantly. Ultimately, a gun program's success still comes down to the experience of the lead designer, his or her creativity, the help of other designers on the team, the assistance and observations he or she receives from the test lab personnel, suggestions used from valued model makers, and process engineers who can keep the design team on the right track.

Feed-system design is a critical aspect for any semi-automatic or full automatic gun design. This is especially true for box-fed firearms, for which magazine development can be half the development design time for a gun. Subtle dimensional changes in magazine box lip geometry can have major impacts on gun performance. Today, high-speed photography can help a designer diagnose why a gun is experiencing feed difficulties, but this technology was not available to the Thompson design team. By developing a funnel-feed geometry to guide the rounds to the chamber, they came up with a design that mitigated the differences between magazines.

The following is a timeline for the Thompson's development from initial program concept to the final M1A1 design variation.

M1A1 Development Timeline

Date	Activity	Comment
1913 & 1915	John Blish applies for a patent for a delayed blowback device.	See Patent No. 1,131,319
1915	John Thompson contacts Blish about collaboration on a new rifle design using his patent.	
August 1916	Thompson obtains from Thomas Ryan the funds necessary to begin Auto-Ordnance Corporation. Thompson contacts Warner and Swasey in Cleveland to assist in the machining of prototypes.	Theodore Eickhoff is hired as Chief Engineer of the new company, George Goll is hired as a Design Assistant, and Oscar Payne is hired as Chief Assistant.
November 1916	Warner and Swasey complete a test prototype mechanism with the Blish system.	
February 1917	Auto-Ordnance opens a small office in Cleveland to be closer to the prototypes.	Eickhoff moves to Cleveland.
May 1917	Prototype testing is ongoing but with great difficulties.	Eickhoff determines that the rifle under development needs lubricated cases to work reliably.
July 1917	Oscar Payne is hired and reports to Eickhoff in Cleveland.	
August 1917	Autorifle Model I in 30-06-caliber fails catastrophically.	Oscar Payne is assigned to redesign the Blish lock for the Model I Autorifle.
September 1917	Eickhoff travels to see Thompson to discuss progress and the "coefficient of extraction" work he had performed. Eickhoff informs Thompson that the only cartridge that will be usable using the Blish system is .45 ACP (Automatic Colt Pistol)	Thompson tells him to drop the rifle and begin work for a machine gun using this round.
October 1917	The first sample of the submachine gun is made, and testing starts. The design is based on Oscar Payne's design work and using .45 ACP ammunition.	The gun is called the "Persuader." The feed system was belt feed.

Date	Activity	Comment
March 1918	The new model is called the "Annihilator."	The feed system is changed to a box design based on performance gains using this feed system.
July 1918	The "Annihilator's" major problems appear to be solved, and work changes to outside cosmetics and durability.	The "Annihilator" was also known as the Model 1919.
August 1918	Additional prototypes are made based on the "Annihilator's" design.	The gun is renamed the "Thompson Submachine Gun."
Nov. 11, 1918	Armistice signed. WWI comes to an end.	Work continues but at a more relaxed pace due to the end of the war.
1919–1920	The team experiments with various prototypes and variations of the gun and basic mechanism. Staff is increased. Payne develops a drum magazine, both 50-round and 100-round versions, and looks at an internal oiling mechanism.	See these patents: No. 1,357,208 No. 1,361,402 No. 1,352,414 No. 1,363,809 No. 1,338,866
December 1919	Marcellus Thompson (John Thompson's son) joins Auto-Ordnance to explore its market possibilities.	
June 1920	John Thompson approaches Colt Co. in Hartford to manufacture the gun under contract. Lyman Sights, Inc. is contracted for the sights; Remington Arms, Inc. is contracted for stocks and forends.	
October 1920	Contracts are finalized.	Auto-Ordnance closes down its Cleveland offices and moves to Hartford.
March 1921	The first guns come off Colt's assembly line.	Only six months of total process development and tool build to begin production.
April 1921	More than 100 guns are made, and sales begin of Model 1921 Thompson submachine guns.	From September 1917 to April 1921 marks approximately 3.5 years of program development, from initial design start to first-production guns.

Date	Activity	Comment
April 1921 to 1922	Sales of Model 1921 guns begin.	The gun is not received well by the general public, the police, or military buyers, but as a gangster weapon, it achieves great notoriety.
1922	Oscar Payne leaves Auto-Ordnance.	
1923	Thompson introduces Model 1923 to help military sales. The price is reduced to $175 from $225. The gun is an instant flop.	The gun has a longer un-finned barrel and a horizontal forend rather than the vertical pistol grip, has a bipod and bayonet, and is chambered for a new, specially developed round .45 Remington–Thompson of greater range and power than the .45 ACP.
1924	Theodore Eickhoff leaves Auto-Ordnance.	
1925	General John Thompson retires from active work with Auto-Ordnance.	
1927	The Marine Corps orders guns for use in Nicaragua. The Navy also becomes interested.	The US Navy requires the rate of fire be reduced from 800-plus rounds per minute (rpm) to 500 rpm.
March 1927	John Thompson contacts Oscar Payne about helping reduce the rpm level of the gun. Payne agrees to do the work in his spare time.	Payne adds weight to the actuator component and gets the rpm level down to 600 rpm, which the Navy accepts. Other part changes are made as well. A Cutt's compensator is also added (see Patent No. 1,636,357)
1928	The Navy accepts the Thompson into its inventory as the US Navy Model of 1928.	1921-version guns are taken out of inventory and altered into the Navy s version.
November 1928	Thomas Ryan dies, and the Ryan estate and Ryan family take control of Auto-Ordnance.	

Date	Activity	Comment
Feb. 14, 1929	In the "St. Valentine's Day Massacre," people with Tommy guns line up six mobsters and a doctor along a wall, then shoot and kill them.	"Tommy guns" are in the possession of the Mafia and gangland groups and are being used in the streets.
1929	The Great Depression begins.	Military funds dry up, offering little chance that foreign countries will adopt the Thompson.
October 1930	Walter Ryan discontinues all sales except to military buyers. This is later changed to include law enforcement agencies.	Tommy guns still find their way to gangsters and criminals—for a price.
April 1932	To increase sales, Ryan contracts Federal Laboratories to be the exclusive seller of the Thompson.	Federal Labs sells guns to many companies to aid in strike-breaking activities and labor disputes.
June 1934	The National Firearms Act is signed into law.	The law levies a heavy excise tax of $200 to transfer and for the unlicensed making of machine guns and other types of firearms.
July 3, 1939	The US Army orders 900 guns.	Sales up to this time are abysmal.
July 1939	Russell Maguire acquires the rights to Auto-Ordnance. The Thompson Automatic Arms Co. is formed with Maguire as president.	This transition of ownership is a story in itself and worth investigation by the reader.
Sept. 1, 1939	Germany invades Poland, and World War II begins.	This changes everything for the company.
Nov. 1939	France orders 3,000 guns.	
Dec. 15, 1939	Savage Firearms is contracted to make Thompsons in Utica, New York, because the company does not have any manufacturing expertise.	These guns are marked with "S."
April 1940	Savage begins delivering finished guns.	They were aided by having much of the production tooling, but it's still a tremendous effort.
February – December 1940	The US Army and the French and British order thousands of guns.	Overnight, the gun goes from obscurity to a vital firearm for the allies.

Date	Activity	Comment
August 1940	Maguire buys property in Bridgeport, Connecticut, for an additional factory to make guns.	
August 1941	The first finished guns begin coming off the Bridgeport line.	These guns are marked with "A.O." (Auto-Ordnance)
August 1940 – April 1942	Manufacturing changes are made to increase production and reduce cost because demand for the gun is so high.	The price is reduced from $209 for the M1928A1 to $70 for the same M1928A1 by the spring of 1942.
November 1941 – April 1942	The gun goes through a redesign to cut production time and costs, resulting in the M1 Thompson. The primary functional design change is the elimination of the Blish "H" lock and the adoption of a full blowback design.	The compensator eliminated, the sight redesigned, cooling fins removed, knurling eliminated, and drum cuts eliminated.
April 1942	The US Army accepts the M1 design.	In July, guns start emerging from the Bridgeport plant.
October 1942	The design is simplified further to reduce costs again, and the gun becomes the M1A1.	The hammer system is eliminated and a fixed firing pin design adopted. Guns start coming off the Savage production line in December.
February 1944	The last M1A1s come off the production lines. By the time production of the Thompson ceased, the grand total of guns produced by Savage and Auto-Ordnance Bridgeport plant is 1,497,334.[7]	The price per gun has dropped to $45 per gun, including accessories.[6]
Mid-1943	The M3 "Grease Gun" starts replacing the "Tommy gun."	This new submachine gun costs less and is easier to manufacture than the Thompson.

From the National Archives and Record Administration
111-SC-197261
With German shells screaming overhead, American Infantrymen seek shelter behind a tank. In the background are the ruins of the town of Geich, Germany. Dec. 11, 1944. This M1A1 Thompson shows the addition of a reinforcing band on the forend.

Chapter 2
Technical Analysis Using Impulse
(No Friction or Elasticity)

The starting point for the technical analysis of the M1A1 design is the question of bolt velocity, which drives many of the system requirements. There has to be enough velocity to have the firearm's bolt travel the length of the receiver to allow consistent feeding and to stop on the sear—the component that stops the firearm from firing further if the trigger is no longer depressed. Bolt recoil velocity in a blowback-operated firearm is dependent primarily on the mass of the recoiling components. Its counter-recoil velocity is dependent on the mass of the recoiling components and the gun's drive spring. These two velocities, added together, determine the cyclic rate of the firearm or its round per minute (rpm) level.

It is hard to know if the design team working on the various Thompson models used the kind of analysis presented here. The experienced designers accomplished a lot through the subsequent testing of design prototypes to refine the design. They did an excellent job of designing an efficient and reliable ammunition processor.

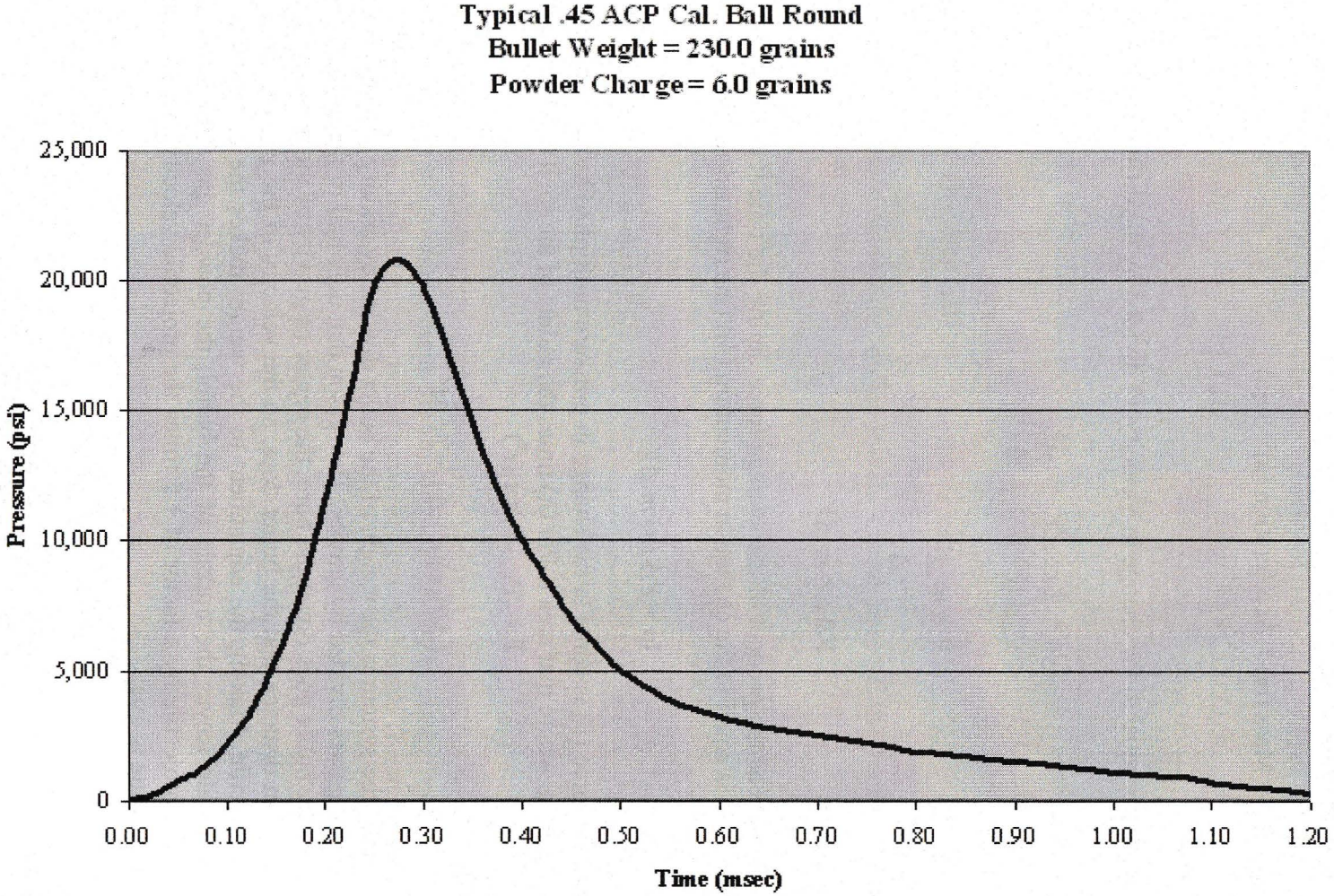
The Thompson M1A1 is a pure blowback automatic submachine gun. While its early predecessors were delayed blowback designs using the Blish Lock "H" piece, the crisis of war and the demand for firearms resulted in this final redesign to lower costs and increase the ease of manufacturing of these weapons. A pure blowback design has no locking system to hold the pressure of the fired ammunition, but rather the inertia of the breech bolt provided by its weight is used to delay the opening of the firearm until the pressures are low enough for the case to be extracted safely from the gun. This type of design is very cost-effective because no complicated locking system is used to restrain the bolt to the barrel during firing. This design eliminates the need for additional locking components, with the accompanying added costs, due to tight tolerances and cam surfaces. The bolt weight and, to a much lesser degree, the action spring are all that is required to keep the bolt held forward sufficiently until the powder pressure reaches safe limits and then lets the action open.

The sequence of functions begins with the indenting of the primer in the cartridge case by the fixed-firing-pin protrusion on the face of the M1A1 breech bolt. When ignition occurs, the bullet will be expelled from the cartridge and move through the barrel, while the breech bolt will move in the opposite direction. Both the breech bolt and the bullet are subject to the same force for the same time from the burning of the propellant charge in the cartridge. The sum of all the products of the force multiplied by the time increment is called the *impulse* (expressed in lb-sec) and is applied equally to both the breech bolt and the bullet. Because the bullet has a much lower weight than the breech bolt, it travels much faster and farther than the bolt does in the same time period, in the opposite direction. This system will work only when the breech bolt is of such a weight, when compared to the bullet, that it does not allow the cartridge case to move too far out of the barrel chamber. If this does occur, the case will rupture and fail because it is unsupported. In practice, blowback-system guns use ammunition with sturdy cases that are relatively short and have favorable pressure–time characteristics. This usually limits blowback weapons to pistol ammunition. There are exceptions to these limitations, but this is the general rule and practice.

The pressure from the powder gases of the fired cartridge can be measured using piezoelectric devices mounted on test barrels, designed for that purpose, that relate those pressures back to the time in which they occurred in the barrel. The pressure-versus-time curve for a typical .45 ACP caliber round of today has a maximum pressure of approximately 20,800 pounds per square inch (psi). The pressure data for the .45 ACP is shown below and graphed.[1] The area beneath the pressure-versus-time curve helps us calculate the round's impulse, and this impulse is equal to the momentum of the bolt assembly.

.45 ACP Pressure Versus Time Data (typical)

Time (msec)	Pressure (psi)	Time (msec)	Pressure (psi)
.000	0	.625	3,000
.025	250	.650	2,800
.050	750	.675	2,650
.075	1,250	.700	2,500
.100	2,200	.725	2,350
.125	3,500	.750	2,200
.150	5,500	.775	2,050
.175	8,000	.800	1,900
.200	11,500	.825	1,800
.225	15,500	.850	1,700
.250	19,750	.875	1,600
.275	20,800	.900	1,500
.300	19,750	.925	1,400
.325	17,250	.950	1,300
.350	14,500	.975	1,200
.375	12,000	1.000	1,100
.400	10,000	1.025	1,000
.425	8,500	1.050	950
.450	7,000	1.075	900
.475	6,000	1.100	700
.500	5,000	1.125	600
.525	4,375	1.150	500
.550	3,875	1.175	400
.575	3,500	1.200	300
.600	3,250		


Typical .45 ACP Cal. Ball Round
Bullet Weight = 230.0 grains
Powder Charge = 6.0 grains
Pressure (psi)
25,000
20,000
15,000
10,000
5,000
0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
Time (msec)

So how do we get the Impulse (Ip) in lbs-seconds, and why do we need it?

From Newton's Second Law:

Force (F) = Mass (m) * Acceleration (a) = m(a)

But:

Acceleration (a) is equal to the change in Velocity(V) divided by the difference in time(t):

$$a = \frac{V_2 - V_1}{t_2 - t_1} = \frac{\Delta V}{\Delta t}$$

Therefore:

$$F = m \frac{\Delta V}{\Delta t}$$

And therefore:

$$F \Delta t = m \Delta V$$

Impulse is known as the product of the average force during the time it acts (the left side of the equation) and is equal to the change in momentum (M) (the right side of the equation).

$$Ip = F \Delta t = m \Delta V$$

In our case, the force (F) is equal to the change in pressure multiplied by the area of the head of the shell casing, where that area is Phi (π) times the radius of the shell head squared.

$$F = (P_2 - P_1)(\pi)(r^2)$$

Therefore:

$$(\Delta P)(\pi)(r^2) \Delta t = m \Delta V$$

The mass (m) of the system is the weight of the bullet divided by gravity plus half the weight of the propellant gasses divided by gravity. The reason that only half of the powder gases are used is that as the bullet goes down the bore, the center of gravity of the gasses travels only half the change in distance that the bullet does, so the velocity of the powder gases is half that of the projectile. Making the adjustment to the weight makes the calculations easier. Once the projectile leaves the muzzle of the barrel, the powder gas velocity is actually greater than the projectile by a factor of 1.5 times the projectile velocity, but for inside the barrel, the following is true:

$$m = \frac{W_{bullet}}{(7000)/g} + \frac{W_{powder}}{(2)\,(7000)/g}$$

Where 7000 grains/pound is the conversion factor to convert the bullet and powder weight of grains into pounds. The gravity constant, g, is 32.2 (ft/sec^2).

Now, solving for Velocity (V), in our case the velocity of the bullet, we get the following:

$$\Delta V = \frac{F \Delta t}{m} = \frac{(\Delta P)(\pi)(r^2)\,\Delta t}{m} = \frac{(\Delta P)(\pi)(r^2)\,\Delta t\,(g)}{\frac{W_{bullet}}{(7000)} + \frac{W_{powder}}{(2)(7000)}}$$

$$\text{Or} \quad = \frac{Ip\,(g)}{\frac{W_{bullet}}{(7000)} + \frac{W_{powder}}{(2)(7000)}}$$

And with Distance (ΔD) $= \frac{\Delta V}{\Delta t}$

We can solve for the distance the bullet travels in the bore of the barrel by using the following equation and relationship:

$$\text{Distance } (\Delta D) = \frac{(\Delta P)(\pi)(r^2)\,(\Delta t)^2\,(g)}{\frac{W_{bullet}}{(7000)} + \frac{W_{powder}}{(2)(7000)}}$$

or $$\text{Distance } (\Delta D) = \frac{Ip\,(g)\,\Delta t}{\frac{W_{bullet}}{(7000)} + \frac{W_{powder}}{(2)(7000)}}$$

With the preceding data and analysis, we can determine several important characteristics of the gun, among them the impulse of the round acting on the bolt breech face, the velocity of the bullet, and the bullet movement in the barrel. The published standard velocity of the .45 ACP 230-grain full metal jacket round, fired from a five-inch barrel, is commonly recognized as 850 feet per second.[2]

Using the analysis provided confirmed this approximation in the bullet travel calculations that follow. See Appendix II to set up your own analysis.

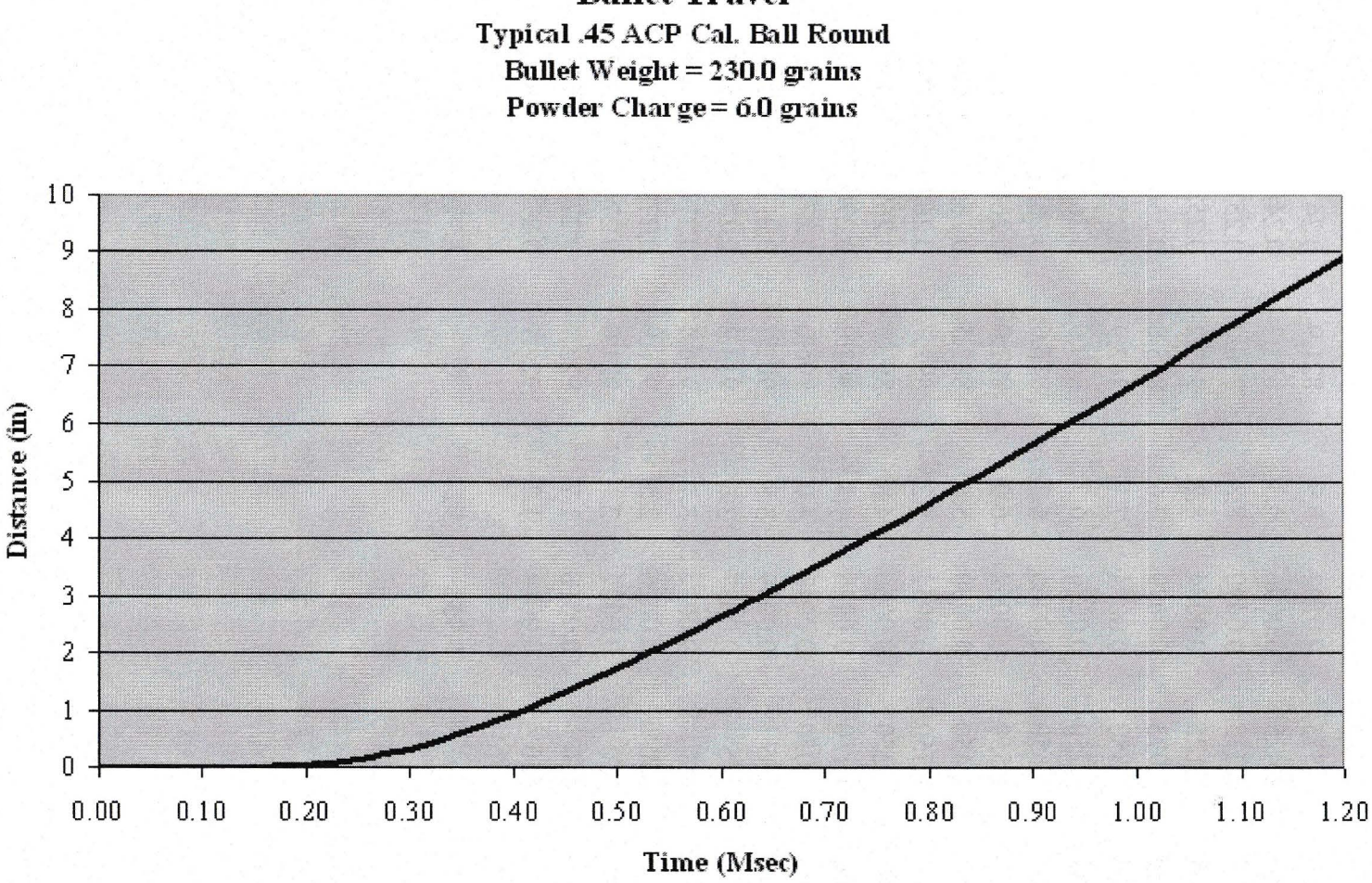
Bullet Travel Calculations

.45-Cal ACP Pistol Cartridge

Typ. Projectile Weight (grains) =	230.0	Inputs in Grey
Typical Powder Charge (grains) =	6.0	
Cartridge Dia. (in) =	0.450	
Cartridge Area (in^2) =	0.159	

Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (F*time) (lb-sec)	Velocity Change (ft/sec)	Velocity Absolute (ft/sec)	Distance Change (in)	Distance Absolute (in)
0.0000	0	0	0.0000	0.0	0.0	0	0
0.0250	250	125	0.0005	0.5	0.5	0.000	0.000
0.0500	750	500	0.0020	1.9	2.4	0.000	0.001
0.0750	1,250	1,000	0.0040	3.8	6.3	0.001	0.002
0.1000	2,200	1,725	0.0069	6.6	12.9	0.003	0.005
0.1250	3,500	2,850	0.0113	11.0	23.8	0.006	0.010
0.1500	5,500	4,500	0.0179	17.3	41.2	0.010	0.020
0.1750	8,000	6,750	0.0268	26.0	67.1	0.016	0.036
0.2000	11,500	9,750	0.0388	37.5	104.6	0.026	0.062
0.2250	15,500	13,500	0.0537	51.9	156.5	0.039	0.101
0.2500	19,750	17,625	0.0701	67.8	224.3	0.057	0.158
0.2750	20,800	20,275	0.0806	78.0	302.3	0.079	0.237
0.3000	19,750	20,275	0.0806	78.0	380.3	0.102	0.340
0.3250	17,250	18,500	0.0736	71.2	451.5	0.125	0.464
0.3500	14,500	15,875	0.0631	61.1	512.5	0.145	0.609
0.3750	12,000	13,250	0.0527	51.0	563.5	0.161	0.770
0.4000	10,000	11,000	0.0437	42.3	605.8	0.175	0.946
0.4250	8,500	9,250	0.0368	35.6	641.4	0.187	1.133
0.4500	7,000	7,750	0.0308	29.8	671.2	0.197	1.330
0.4750	6,000	6,500	0.0258	25.0	696.2	0.205	1.535
0.5000	5,000	5,500	0.0219	21.2	717.3	0.212	1.747
0.5250	4,375	4,688	0.0186	18.0	735.4	0.218	1.965
0.5500	3,875	4,125	0.0164	15.9	751.2	0.223	2.188
0.5750	3,500	3,688	0.0147	14.2	765.4	0.227	2.415
0.6000	3,250	3,375	0.0134	13.0	778.4	0.232	2.647

0.6250	3,000	3,125	0.0124	12.0	790.4	0.235	2.882
0.6500	2,800	2,900	0.0115	11.2	801.6	0.239	3.121
0.6750	2,650	2,725	0.0108	10.5	812.0	0.242	3.363
0.7000	2,500	2,575	0.0102	9.9	821.9	0.245	3.608
0.7250	2,350	2,425	0.0096	9.3	831.3	0.248	3.856
0.7500	2,200	2,275	0.0090	8.8	840.0	0.251	4.107
0.7750	2,050	2,125	0.0084	8.2	848.2	0.253	4.360
0.8000	1,900	1,975	0.0079	7.6	855.8	0.256	4.616
0.8250	1,800	1,850	0.0074	7.1	862.9	0.258	4.873
0.8500	1,700	1,750	0.0070	6.7	869.6	0.260	5.133
0.8750	1,600	1,650	0.0066	6.3	876.0	0.262	5.395
0.9000	1,500	1,550	0.0062	6.0	882.0	0.264	5.659
0.9250	1,400	1,450	0.0058	5.6	887.5	0.265	5.924
0.9500	1,300	1,350	0.0054	5.2	892.7	0.267	6.191
0.9750	1,200	1,250	0.0050	4.8	897.5	0.269	6.460
1.0000	1,100	1,150	0.0046	4.4	902.0	0.270	6.730
1.0250	1,000	1,050	0.0042	4.0	906.0	0.271	7.001
1.0500	950	975	0.0039	3.8	909.7	0.272	7.273
1.0750	900	925	0.0037	3.6	913.3	0.273	7.547
1.1000	700	800	0.0032	3.1	916.4	0.274	7.821
1.1250	600	650	0.0026	2.5	918.9	0.275	8.096
1.1500	500	550	0.0022	2.1	921.0	0.276	8.372
1.1750	400	450	0.0018	1.7	922.7	0.277	8.649
1.2000	300	350	0.0014	1.3	924.1	0.277	8.926
Summation			**0.955**	**924**		**8.926**	


Bullet Travel
Typical .45 ACP Cal. Ball Round
Bullet Weight = 230.0 grains
Powder Charge = 6.0 grains
Distance (in)
10
9
8
7
6
5
4
3
2
1
0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
Time (Msec)

The impulse that acted on the bullet also acts on the breech face of the bolt, forcing the bolt rearward. We can use this same analysis to find the recoil velocity of the bolt, where:

$$\text{Recoil } \Delta V = \frac{\text{Ip (g)}}{\text{Weight of the recoiling parts}}$$

and $$\text{Distance } \Delta D = \frac{\text{Ip (g) } \Delta t}{\text{Weight of the recoiling parts =}}$$

(bolt + 1/3 the action spring + extractor + bolt handle)

We use only one-third of the action spring weight due to the nature of spring surge, and this factor is an approximation of the effect the spring mass has on the system as a whole. By knowing the recoil velocity and the distance of the total bolt stroke, we can determine the time of recoil. We must remember that this analysis is not taking into account friction or any other retarding forces that act on the bolt as it travels rearward to impact the back of the receiver.

$$\text{Distance } (\Delta D) = \frac{\Delta V}{\Delta t_{recoil}}$$

Therefore: $$\Delta t_{recoil} = \frac{\Delta V}{\Delta D}$$

The time for counter-recoil is derived from the conservation of energy principle. The energy stored in the action spring from the bolt compressing it is released as kinetic energy as the bolt is accelerated forward.

$$\frac{MrVf^2}{2} = Fo(d) + \frac{Kd^2}{2}$$

Where:

Mr	=	Mass of the recoiling components
Vf	=	Velocity of the components going forward
Fo	=	Initial compressive force of the action spring
K	=	The action spring's spring constant
d	=	The distance the bolt has traveled forward

Solving for Vf yields:

$$Vf = \sqrt{\frac{2(Fo)\,d}{Mr} + \frac{K\,d^2}{Mr}}$$

And again:

$$\text{Distance } (\Delta d) = \frac{\Delta V}{D\,t_{\text{counter recoil}}}$$

$$\Delta\, t_{\text{counter recoil}} = \frac{\Delta V}{\Delta d}$$

With both an estimated time for recoil and counter-recoil, we can now calculate a theoretical maximum rpm figure because we are not taking into account friction, the coefficient of restitution, or other retarding forces using the following equation:

$$rpm = \frac{60}{D\,t_{\text{recoil}} + D\,t_{\text{counter recoil}}}$$

With the preceding equations, an analysis was done with the following results. See Appendix III to set up your own analysis.

M1A1 Gun Analysis Based On Round Impulse and No Retarding Forces

.45 Cal ACP Pistol
Cartridge

Typ. Projectile Weight (grains) =	230.0
Typical Powder Charge (grains) =	6.0
Cartridge Dia. (in) =	0.450
Bolt Weight (lbs) =	1.769
Extractor Wgt (lbs) =	0.0124
Handle Weight (lbs) =	0.072
Spring Weight (lbs) =	0.03
Bolt Stroke D (in) =	3.790
Spg. Rate K (lbs/in) =	1.59
Spg. Force Fo (lbs) =	5.70
Wgt. of Recoiling Parts Wr (lbs) =	1.863
Grav. Constant - g (lbs-sec2/in) =	386.4
Recoiling Mass Mr =	0.005

Inputs in Grey

Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Bolt Recoil Velocity Change (in/sec)	Bolt Recoil Velocity Absolute (in/sec)	Bolt Recoil Travel Increment (in)	Bolt Recoil Travel Absolute (in)
0.0000	0	0	0.0000	0.0	0	0	0
0.0250	250	125	0.0005	0.1	0.1	0.000	0.000
0.0500	750	500	0.0020	0.4	0.5	0.000	0.000
0.0750	1,250	1,000	0.0040	0.8	1.3	0.000	0.000
0.1000	2,200	1,725	0.0069	1.4	2.8	0.000	0.000
0.1250	3,500	2,850	0.0113	2.3	5.1	0.000	0.000
0.1500	5,500	4,500	0.0179	3.7	8.8	0.000	0.000
0.1750	8,000	6,750	0.0268	5.6	14.4	0.000	0.001
0.2000	11,500	9,750	0.0388	8.0	22.4	0.000	0.001
0.2250	15,500	13,500	0.0537	11.1	33.6	0.001	0.002
0.2500	19,750	17,625	0.0701	14.5	48.1	0.001	0.003
0.2750	20,800	20,275	0.0806	16.7	64.8	0.001	0.004
0.3000	19,750	20,275	0.0806	16.7	81.5	0.002	0.006
0.3250	17,250	18,500	0.0736	15.3	96.8	0.002	0.008
0.3500	14,500	15,875	0.0631	13.1	109.9	0.003	0.011
0.3750	12,000	13,250	0.0527	10.9	120.8	0.003	0.014
0.4000	10,000	11,000	0.0437	9.1	129.9	0.003	0.017

0.4250	8,500	9,250	0.0368	7.6	137.5	0.003	0.020
0.4500	7,000	7,750	0.0308	6.4	143.9	0.004	0.024
0.4750	6,000	6,500	0.0258	5.4	149.2	0.004	0.027
0.5000	5,000	5,500	0.0219	4.5	153.8	0.004	0.031
0.5250	4,375	4,688	0.0186	3.9	157.6	0.004	0.035
0.5500	3,875	4,125	0.0164	3.4	161.0	0.004	0.039
0.5750	3,500	3,688	0.0147	3.0	164.1	0.004	0.043
0.6000	3,250	3,375	0.0134	2.8	166.9	0.004	0.047
0.6250	3,000	3,125	0.0124	2.6	169.4	0.004	0.051
0.6500	2,800	2,900	0.0115	2.4	171.8	0.004	0.056
0.6750	2,650	2,725	0.0108	2.2	174.1	0.004	0.060
0.7000	2,500	2,575	0.0102	2.1	176.2	0.004	0.064
0.7250	2,350	2,425	0.0096	2.0	178.2	0.004	0.069
0.7500	2,200	2,275	0.0090	1.9	180.1	0.004	0.073
0.7750	2,050	2,125	0.0084	1.8	181.8	0.005	0.078
0.8000	1,900	1,975	0.0079	1.6	183.4	0.005	0.082
0.8250	1,800	1,850	0.0074	1.5	185.0	0.005	0.087
0.8500	1,700	1,750	0.0070	1.4	186.4	0.005	0.092
0.8750	1,600	1,650	0.0066	1.4	187.8	0.005	0.096
0.9000	1,500	1,550	0.0062	1.3	189.1	0.005	0.101
0.9250	1,400	1,450	0.0058	1.2	190.2	0.005	0.106
0.9500	1,300	1,350	0.0054	1.1	191.4	0.005	0.111
0.9750	1,200	1,250	0.0050	1.0	192.4	0.005	0.115
1.0000	1,100	1,150	0.0046	0.9	193.3	0.005	0.120
1.0250	1,000	1,050	0.0042	0.9	194.2	0.005	0.125
1.0500	950	975	0.0039	0.8	195.0	0.005	0.130
1.0750	900	925	0.0037	0.8	195.8	0.005	0.135
1.1000	700	800	0.0032	0.7	196.4	0.005	0.140
1.1250	600	650	0.0026	0.5	197.0	0.005	0.145
1.1500	500	550	0.0022	0.5	197.4	0.005	0.150
1.1750	400	450	0.0018	0.4	197.8	0.005	0.154
1.2000	300	350	0.0014	0.3	198.1	0.005	0.159
Summation			**0.955**		**198.1**		

RPM Analysis

Avg Recoil Vel Vr =	99	in/sec
Recoil Time =	0.0383	sec
Count. Recoil Vel =	117	in/sec
Counter Recoil Time =	0.0324	sec
Rounds per Minute =	849	rpm

From this quick analysis, we can make several conclusions. The first is that the case of the .45 ACP round travels approximately .004" rearward by the time the case sees maximum pressure. A second observation is that the case has moved .159" by the time the bullet exits the barrel. Both of these seem to be acceptable constraints to prevent case failure and indicate that the bolt is heavy enough to do its job. A third observation is that the round per minute level calculated without any friction considerations gives a theoretical maximum rpm value of 849. This, too, is a rational number for this type of gun and also indicates that the recoiling mass of the parts is probably within good values, but from published rpm values for the M1A1 Thompson, this analysis is giving us too high a cyclic rate.

While this analysis is helpful to make a rough determination of round and gun performance, it is limited because it does not consider all the factors that affect gun performance. Friction, which is always present, slows the gun down in both recoil and counter-recoil. In addition, the angle of the gun as it is fired can also impact the rpm level through the influence of gravity. This analysis also does not take into account the rebound velocity of the bolt hitting the back of the receiver through the elasticity of that collision (coefficient of restitution). We also have retarding friction forces from components in contact with the bolt. These effects can be calculated with a more rigorous analysis, which follows in Chapter III.

From the National Archives and Record Administration
127-GW-877-90450
These two soldiers were with a group of Marines carrying bazooka ammo up to the front lines until they were stopped by sniper fire. Tinian, July 23, 1944.
The soldier on the left has an M1 Carbine.
The soldier on the right has an M1A1 Thompson.

Chapter 3
Technical Analysis
Considering Friction and Elasticity

The first step in this more rigorous investigation will be to derive a number of important equations relating to the motion of the bolt. These derivations will all be based on the fact that as the bolt moves in recoil, the driving spring absorbs and stores energy. While this analysis starts with the approach of Lt. Colonel George Chinn in his book *The Machine Gun, Design Analysis of Automatic Firing Mechanisms and Related Components Volume IV, Parts X and X,* it considers the effects of friction, firing angle, and the effect of the bolt's impact at the rear of the receiver, where Chinn's analysis did not. As will be shown, these effects are considerable.

If we approach the problem based on a conservation of energy, then the energy remaining in the bolt at any time during its recoil stroke with the bolt moving to the rear is expressed by the following equation[1]:

$$\frac{MrVr^2}{2} = Er - (Fod + fd + \frac{Kd^2}{2})$$

Where:

Mr	=	Mass of the recoiling components
Vr	=	Velocity of the recoiling components
Er	=	Initial energy available to do work
Fo	=	Initial compressive force on the bolt from the action spring
f	=	The retarding frictional forces
K	=	The action spring's spring constant
d	=	The distance the bolt has traveled

This equation may be used for deriving the equation expressing the relationship between time and the bolt's rearward motion. Solving for Vr, the velocity of the recoiling components, results in the following:

$$\frac{MrVr^2}{2} = Er - (Fo + f)d - \frac{Kd^2}{2}$$

$$Vr^2 = \frac{-Kd^2}{Mr} - \frac{2(Fo+f)d}{Mr} + \frac{2Er}{Mr}$$

$$Vr = \sqrt{\frac{-Kd^2}{Mr} - \frac{2(Fo+f)d}{Mr} + \frac{2Er}{Mr}}$$

Because velocity is equal to the change in distance divided by the change in time:

$$Vr = \frac{dd}{dt} = \sqrt{\frac{-K}{Mr}d^2 - \frac{2(Fo+f)}{Mr}d + \frac{2Er}{Mr}}$$

$$dt = \frac{dd}{\sqrt{\frac{-K}{Mr}d^2 - \frac{2(Fo+f)}{Mr}d + \frac{2Er}{Mr}}}$$

From a table of integrals, we find the following solution:

$$\frac{dd}{\sqrt{ad^2 + bd + c}} = \frac{1}{\sqrt{-a}} \sin^{-1} \frac{-2ad - b}{\sqrt{b^2 - 4ac}} + C$$

Where:

$$a = \frac{-K}{Mr}$$

$$b = \frac{-2(Fo + f)}{Mr}$$

$$c = \frac{2Er}{Mr}$$

Therefore:

$$t = \sqrt{\frac{Mr}{K}} \sin^{-1} \left[\frac{\frac{2K}{Mr}d + \frac{2(Fo + f)}{Mr}}{\sqrt{\frac{4(Fo + f)^2}{Mr^2} + \frac{8KEr}{Mr^2}}} \right] + C$$

$$t = \sqrt{\frac{Mr}{K}} \sin^{-1} \left[\frac{\frac{2}{Mr}Kd + \frac{2}{Mr}(Fo + f)}{\frac{2}{Mr}\sqrt{Fo^2 + 2Fof + f^2 + 2KEr}} \right] + C$$

$$t = \sqrt{\frac{Mr}{K}} \sin^{-1}\left[\frac{Kd + Fo + f}{\sqrt{Fo^2 + 2Fof + f^2 + 2KEr}}\right] + C$$

If we assign the term $\sqrt{Fo^2 + 2Fof + f^2 + 2KEr}$ to be equal to Q

Then substituting this back into the expression for t gives the following:

$$t = \sqrt{\frac{Mr}{K}} \sin^{-1}\left[\frac{Kd + Fo + f}{Q}\right] + C$$

At t = 0, d = 0; therefore:

$$C = -\sqrt{\frac{Mr}{K}} \sin^{-1}\left[\frac{Fo + f}{Q}\right]$$ this leaves us with:

$$t = \sqrt{\frac{Mr}{K}}\left[\sin^{-1}\frac{Kd + Fo + f}{Q} - \sin^{-1}\frac{Fo + f}{Q}\right]$$

This provides the formula for describing the movement of the recoiling components. Solving this equation for distance (d) as a function of time (t) yields the following:

$$d = \frac{Q \sin\left[(t)\sqrt{\frac{K}{Mr}} + \sin^{-1}\frac{Fo + f}{Q}\right] - Fo - f}{K}$$

Remembering that : $\sqrt{Fo^2 + 2Fof + f^2 + 2KEr} = Q$

We need to define Er as the initial energy available to push the bolt rearward, and this is equal to:

$$Er = \tfrac{1}{2} Mr\ (Vbolt)^2$$

We determine the velocity of free recoil as being equal to the area under the pressure-versus-time curve divided by the mass of the recoiling parts due to the following reasoning:

Force	=	Mass * Acceleration
$F_{pressure}$	=	Mass * Velocity Bolt/Time
Vbolt	=	Pressure(Bore Area)(t)/Mr
Vbolt	=	Impulse/Mr = I / Mr

Then: $Er = \tfrac{1}{2} Mr\ (I / Mr)^2$

$$Er = \tfrac{1}{2} I^2 / Mr$$

Substituting:

$$t = \sqrt{\frac{Mr}{K}} \left[\sin^{-1} \frac{Kd + Fo + f}{\sqrt{Fo^2 + 2Fof + f^2 + \frac{KI^2}{Mr}}} - \sin^{-1} \frac{Fo + f}{\sqrt{Fo^2 + 2Fof + f^2 + \frac{KI^2}{Mr}}} \right]$$

$$d = \frac{\sqrt{Fo^2 + 2Fof + f^2 + \frac{KI^2}{Mr}} \sin \left[(t) \sqrt{\frac{K}{Mr}} + \sin^{-1} \frac{Fo + f}{\sqrt{Fo^2 + 2Fof + f^2 + KI^2}} \right] - Fo - f}{K}$$

This same type of analytical procedure can be done to determine the equations for motion for the bolt moving forward. Here the stored energy of the recoil or action spring drives the bolt forward retarded by the friction forces. Again, from the conservation of energy standpoint, the following is true:

$$\frac{MrVf^2}{2} = \begin{matrix}\text{Energy Stored} \\ \text{by the spring}\end{matrix} - \begin{matrix}\text{Energy} \\ \text{Expended}\end{matrix} - \begin{matrix}\text{frictional} \\ \text{losses}\end{matrix} + \begin{matrix}\text{Rebound Energy} \\ \text{from Bolt Impact}\end{matrix}$$

$$\frac{MrVf^2}{2} = FoD + \frac{KD^2}{2} - \left[Fo(D-d) + \frac{K}{2}(D-d)^2 \right] - fd + \frac{MrVi^2}{2}$$

Where:

Mr	=	Mass of the bolt components
Vf	=	Velocity of the bolt components back into battery
Vi	=	Resultant velocity of the bolt impact with the receiver
e	=	Coefficient of restitution of the bolt impact
Fo	=	Initial compressive force on the bolt from the action spring
f	=	The retarding frictional forces
K	=	The action spring's spring constant
d	=	The distance the bolt has traveled
D	=	Total bolt travel in recoil

The coefficient of restitution, e, is a ratio that defines the difference between the impact velocity and the rebound velocity from the impact of one body with another. A coefficient of restitution of 1 implies a perfectly elastic collision, where the rebound velocity is equal to the impact velocity; no loss of velocity occurs. A coefficient of restitution of 0 implies that the impact force and velocity are totally absorbed by the impact of one body with another. This coefficient is not totally a material property; a part's geometry affects this number as well as how the collision takes place. Regardless, the coefficient is the ratio between the impact velocities of the bolt impact to its rebound velocity. Therefore:

$$e = Vi/Vr \quad \text{or} \quad Vr(e) = Vi$$

and then,

$$\frac{MrVf^2}{2} = FoD + \frac{KD^2}{2} - FoD + Fod - \frac{KD^2}{2} + KDd - \frac{Kd^2}{2} - fd + \frac{MrVr^2 e^2}{2}$$

$$\frac{MrVf^2}{2} = FoD + KDd - \frac{Kd^2}{2} - fd + \frac{MrVr^2 e^2}{2}$$

$$\frac{MrVf^2}{2} = -\frac{Kd^2}{2} + d(Fo + KD - f) + \frac{MrVr^2 e^2}{2}$$

Solving for Vf yields:

$$Vf = \sqrt{-\frac{K}{Mr}d^2 + \frac{2d}{Mr}(Fo+KD-f) + Vr^2 e^2}$$

$$dTt = \frac{dd}{\sqrt{-\frac{K}{Mr}d^2 + \frac{2d}{Mr}(Fo+KD-f) + Vr^2 e^2}}$$

$$dTt = \frac{dd}{\sqrt{\frac{2(Fo+KD-f)}{K}d - d^2 + \frac{Mr}{K}Vr^2 e^2}} \sqrt{\frac{Mr}{K}}$$

From a table of integrals:

$$\frac{dd}{\sqrt{-d^2 + 2ad + B}} = \tan^{-1}\left[\frac{(d-a)\sqrt{-d^2 + 2ad + B}}{d^2 + 2ad - B}\right] + C$$

Where $a = \frac{Fo + KD - f}{K}$

$$B = \frac{MrVr^2 e^2}{K}$$

$$Tt = \sqrt{\frac{Mr}{K}} \tan^{-1}\left[\frac{(d-a)\sqrt{-d^2+2ad+B}}{d^2+2ad-B}\right] + C$$

At $t = 0, d = 0$ so:

$$C = -\sqrt{\frac{Mr}{K}} \tan^{-1}\left[\frac{-a\sqrt{B}}{-B}\right]$$

This results in the following:

$$Tt = \sqrt{\frac{Mr}{K}}\left[\tan^{-1}\left[\frac{(d-a)\sqrt{-d^2+2ad+B}}{d^2+2ad-B}\right] - \tan^{-1}\left[\frac{-a\sqrt{B}}{-B}\right]\right]$$

The counter-recoil time is solved by replacing D for d to yield the following:

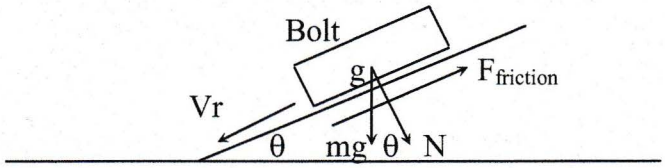
$$Tt = \sqrt{\frac{Mr}{K}}\left[\tan^{-1}\left[\frac{(D-a)\sqrt{-D^2+2aD+B}}{D^2+2aD-B}\right] - \tan^{-1}\left[\frac{-a\sqrt{B}}{-B}\right]\right]$$

Having done this portion of the analysis, we can now turn our attention to the frictional forces that are involved in retarding the bolt travel and define more clearly the (f) term in our calculations.

The first of these is the sliding friction that occurs between the bolt and the housing or receiver that houses the bolt assembly. This force acts over the entire distance the bolt moves and is a function of the particular elevation the firearm is fired at; when firing straight up at 90°, this retarding force is 0, and when horizontal is equal to the weight of the bolt assembly times the coefficient of friction. The relation that governs this type of behavior is as follows:

Friction = σ (Wr)(cosθ) where:

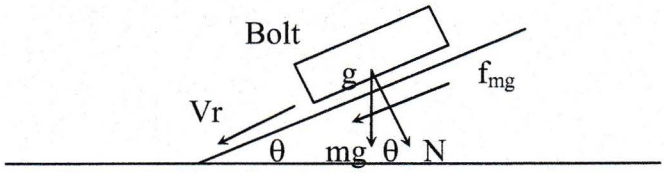
σ = Coefficient of friction
Wr = Recoiling components part weights
θ = Angle of elevation



N/mg = cos θ
F = σN
mg = Wr

The second retarding force to be considered is gravity. Again, depending on the elevation, this force can affect the cyclic rate of the gun. If pointed downward during the rearward motion of the bolt assembly, gravity will resist the motion, and when the barrel is pointed upward, it will aid recoil. While the gun is horizontal, this force is not present. The relation that covers this behavior is:

f_{mg} = mg sin θ



f_{mg}/mg = sin θ
f_{mg} = mg sin θ
f_{mg} = Wr sin θ

Another frictional force to be overcome is that from the magazine box. This comes in two forms. The first is the force necessary to strip shells from the magazine box and feed them into the chamber. The second is the frictional forces acting during counter recoil, where the next round to be fed presses upward on the bolt as it travels to the rear.

Generally, both of these forces can be ignored as the distance that they act over is short, the frictional coefficient is low, and, for the force pressing up against the bolt, is partially negated by the weight of the bolt itself. Dividing the model into four discreet sections—two for recoil stroke and two for counter recoil—is also avoided by ignoring this effect. The force of the magazine spring is the largest variable for this frictional force.

Another variable to the cyclic rate is the shoulder of the shooter firing the weapon. Generally, smaller/lighter individuals will not control the gun when it is firing as well as large-stature/heavier individuals. This causes the gun to move to the rear more, and the relative velocity of the bolt to the receiver is reduced. This affects the coefficient of restitution as well by reducing it. In submachine guns, this effect is lessened in comparison with light machine guns due to the impulse of pistol cartridges being much less relative to the weight of the gun. The Thompson is relatively heavy for a gun in this class, and this effect is further lessened. For .22-caliber rifles, this effect is minimal. Testing is usually the best way to determine how the relative velocity condition will affect the gun's performance because it changes not only the bolt velocity but also the feeding dynamics of the cartridges. Allowing for "heavy"-shoulder versus "light"-shoulder shooters is a condition that all gun designers need to verify through extensive shooting tests. Most analyses that consider the shooter's shoulder attempt to model it as a spring-and-dash-pot system with different initial conditions for the two shoulder types. As it will be subsequently shown, good results are obtainable without taking this variable into account for this class of firearms.

Another variable not considered is recoil spring "surge". When the bolt starts to travel to the rear and after bolt impact with the receiver, the spring coils will generate a harmonic surge wave which reduces the effective load the spring exerts on the bolt. This dynamic condition was not considered in the analysis, but can be accounted for by lowering the coefficient of restitution selection the designer feels is appropriate.

Finally, we come to the problem of case friction during the firing of the gun. Here, too, the frictional forces act for a very short period of time; the surface finish of the chamber is usually very good, which results in low coefficients of friction for the chamber; and the cases may have some oil on them as well, which lessen this bolt velocity effect. As a consequence, this variable was not included in the frictional force calculations. When the analysis of the M1A1 Thompson submachine gun was calculated using the equations previously presented, the following results were obtained for various firing angles:

Firing Angle (degrees)	Coefficient of Restitution (e)	Calculated Recoil Time (sec)	Calculated Counter-Recoil Time (sec)	Calculated rpm Level
90	.001	.0215	.0644	698
45	.001	.0214	.0636	705
0	.001	.0211	.0598	742
-45	.001	.0207	.0559	783
-90	.001	.0204	.0539	807

The full calculation with the firing angle at 0 degrees and the coefficient of elasticity at .001 follows and yields an rpm level of 742.

M1A1 Gun Analysis Based on Derived Formulas and Assuming Frictional Drag and Elasticity

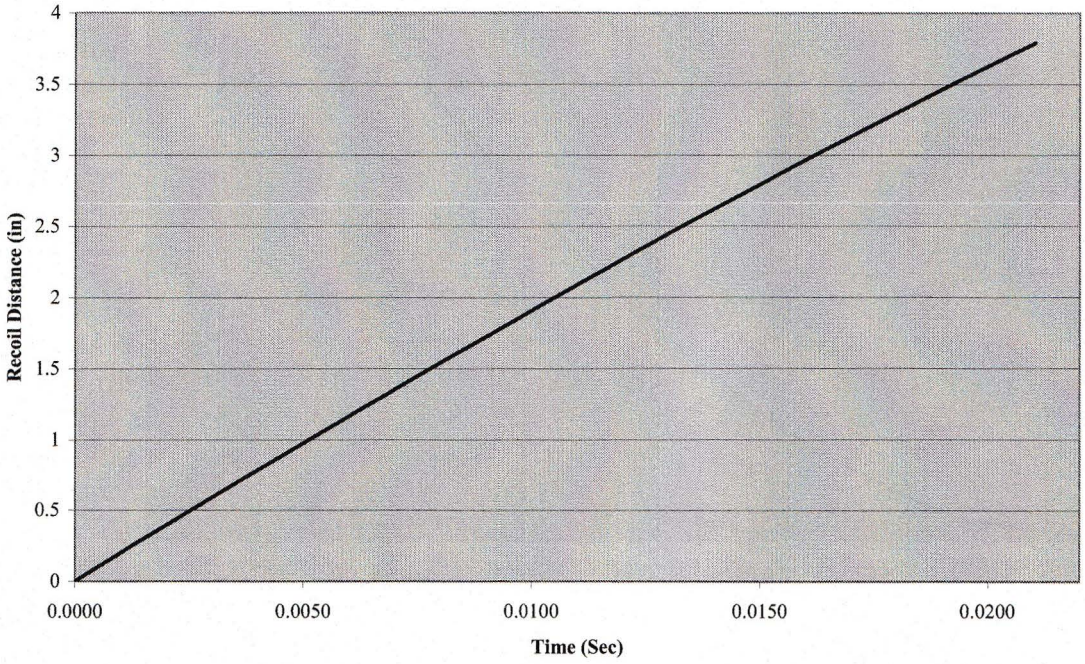
Variables		Input		Calculated		
		Values		Terms		
Bullet Weight (grains)	Wp	.230		Weight of Recoiling Parts	Wt	1.863
Powder Charge Weight (grains)	Pc	6.0		Recoiling Mass	Mr	.0048
Impulse (lbs-sec)	I	.955		Er (in-lbs)	Er	94.6
Bolt Weight (lbs)	Wb	1.769		Q Term	Q	18.40
Extractor Weight (lbs)	We	.0124		a Term	a	7.08
Cocking Handle Weight (lbs)	Wc	.072		B Term	B	0.0
Spring Weight (lbs)	Ws	.03				
Full Bolt Stroke (in)	D	3.790				
Bolt Dynamic Friction Coefficient	σ	.25		Gravity Constant (lbs-sec^2/in)	G	386.4
Initial Spring Force on Bolt (lbs)	Fo	5.70				
Spring Constant (lbs/in)	K	1.59		Calc. Recoil Time (sec)	T	.0211
Firing Angle (degrees)	θ	0.0		Calc. Counter-Recoil Time (sec)	Tt	.0598
Elasticity Coefficient	E	.001		Calc. Rounds per Minute	rpm	742

Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
.0000	0	0.0	0	0	0	0	0	0	0
.0008	.5	0.0	.5	.166	197.5	197.5	.0113	.152	13.4
.0017	.5	0.0	.5	.332	-1.1	196.4	.0161	.303	31.9
.0025	.5	0.0	.5	.496	-1.2	195.2	.0198	.455	41.3
.0034	.5	0.0	.5	.660	-1.2	194.0	.0229	.606	48.7
.0042	.5	0.0	.5	.822	-1.3	192.7	.0256	.758	55.0
.0051	.5	0.0	.5	.983	-1.3	191.4	.0282	.910	60.5
.0059	.5	0.0	.5	1.143	-1.4	190.1	.0305	1.061	65.4
.0067	.5	0.0	.5	1.302	-1.4	188.7	.0326	1.213	69.8
.0076	.5	0.0	.5	1.460	-1.4	187.2	.0347	1.364	73.9
.0084	.5	0.0	.5	1.617	-1.5	185.7	.0366	1.516	77.7
.0093	.5	0.0	.5	1.772	-1.5	184.2	.0385	1.668	81.2
.0101	.5	0.0	.5	1.926	-1.6	182.6	.0403	1.819	84.5
.0110	.5	0.0	.5	2.078	-1.6	181.0	.0420	1.971	87.5

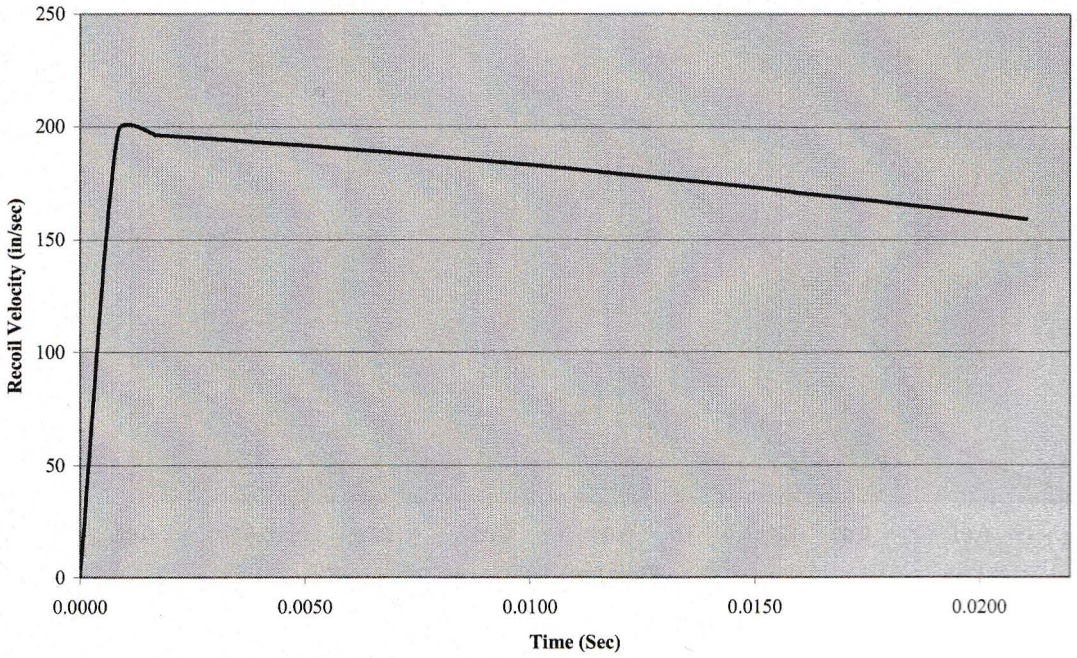
Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
.0118	.5	0.0	.5	2.229	-1.7	179.4	.0437	2.122	90.4
.0126	.5	0.0	.5	2.379	-1.7	177.7	.0453	2.274	93.1
.0135	.5	0.0	.5	2.527	-1.7	175.9	.0469	2.426	95.7
.0143	.5	0.0	.5	2.674	-1.8	174.2	.0485	2.577	98.1
.0152	.5	0.0	.5	2.819	-1.8	172.3	.0500	2.729	100.3
.0160	.5	0.0	.5	2.963	-1.9	170.5	.0515	2.880	102.5
.0169	.5	0.0	.5	3.105	-1.9	168.6	.0529	3.032	104.5
.0177	.5	0.0	.5	3.245	-1.9	166.6	.0543	3.184	106.4
.0185	.5	0.0	.5	3.384	-2.0	164.7	.0557	3.335	108.2
.0194	.5	0.0	.5	3.521	-2.0	162.7	.0571	3.487	110.0
.0202	.5	0.0	.5	3.656	-2.1	160.6	.0585	3.638	111.6
.0211	.5	0.0	.5	3.790	-2.1	158.5	.0598	3.790	113.1

Total Calculated Recoil Time =	.0211
Total Calculated Counter-Recoil Time =	.0598
Calculated Rounds per Minute =	742

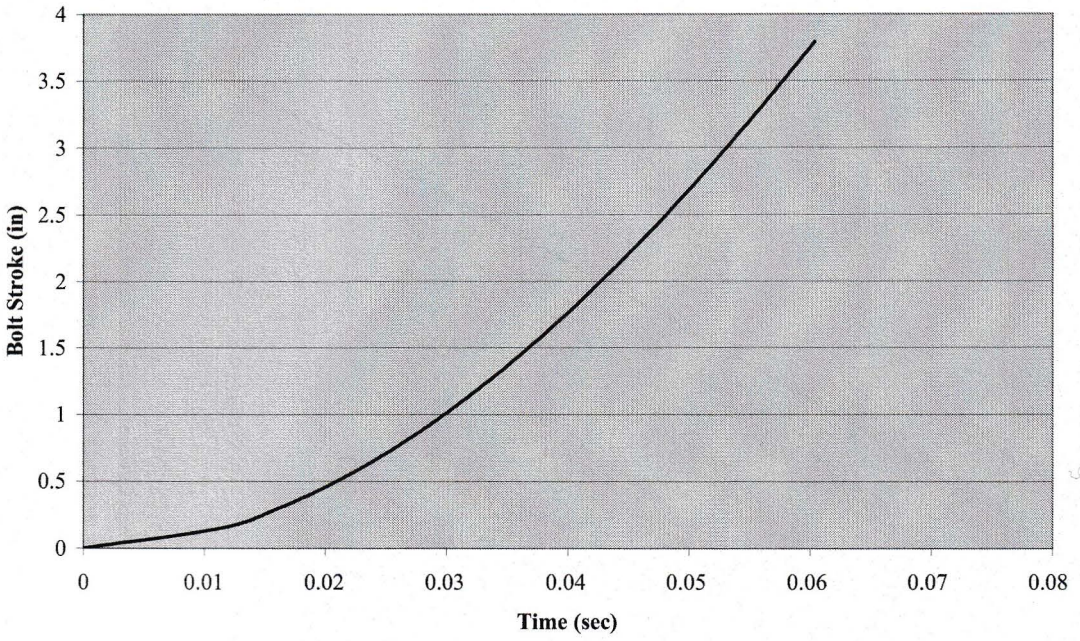
M1A1 Recoil Distance vs. Time



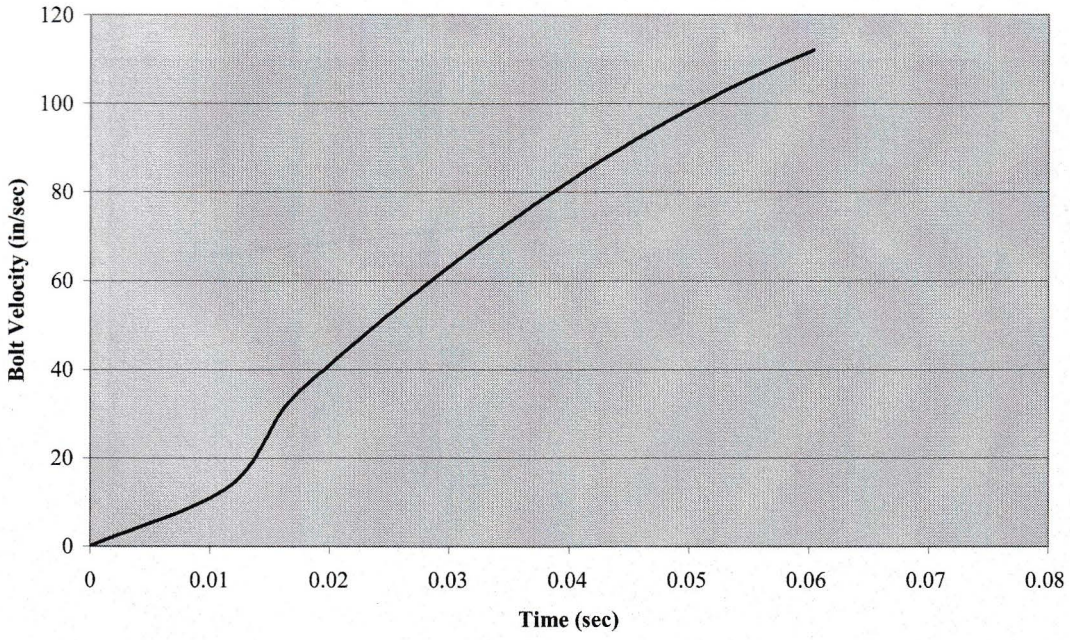
M1A1 Recoil Velocity vs. Time



M1A1 Counter Recoil Distance vs. Time



M1A1 Bolt Return Velocity vs. Time



Varying the coefficient of restitution (e) within some believable limits yielded the following results:

Firing Angle (degrees)	Coefficient of Restitution (e)	Calculated Recoil Time (sec)	Calculated Counter-Recoil Time (sec)	Calculated rpm Level
0	.00	.0211	.0598	742
0	.10	.0211	.0533	806
0	.15	.0211	.0503	841

As can be seen, the coefficient of restitution has a significant effect on the rpm level of the gun, as well as the angle at which the gun is fired. The closest correlation to published M1A1 rpm levels is a coefficient of restitution close to .0 indicating the buffer design is not returning any rebound energy back to the breech bolt even though the bolt is reaching and impacting the rear of the receiver or that this low number is due to recoil spring surge effects which lengthen the counter recoil time.

Appendix IV shows how the reader can set up his or her own Excel spreadsheet to analyze and see the effect of certain parameters on the M1A1 gun's performance or to evaluate your own design.

From the National Archives and Record Administration
127-N-123170
A Marine of the 1st Marine Division draws a bead on a Japanese sniper with his Tommy gun as his companion with a BAR light machine gun ducks for cover. The division is working to take Wana Ridge before the town of Shuri. Okinawa, 1945.

Chapter 4
Technical Analysis
Considering Friction and Elasticity:
"Working Model" Simulation

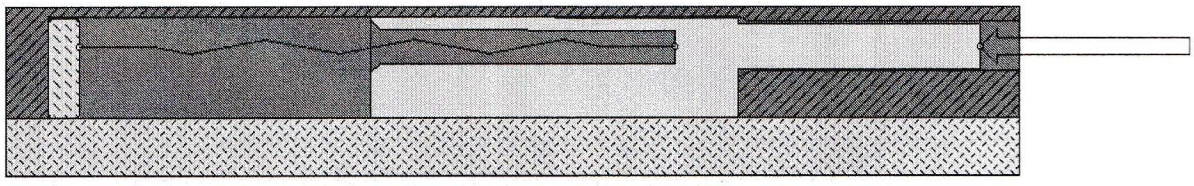
One other method of determining the rpm level of the M1A1 that will be presented is to make a computer model of the gun using Working Model 2D software distributed by Design Simulation Technologies, Inc. This software allows engineers and designers to model problems such as a gun mechanism. With this type of model, we can do both an analysis of the dynamic nature of the mechanism and also perform some "what if" type work by altering the inputs or pieces of the design.

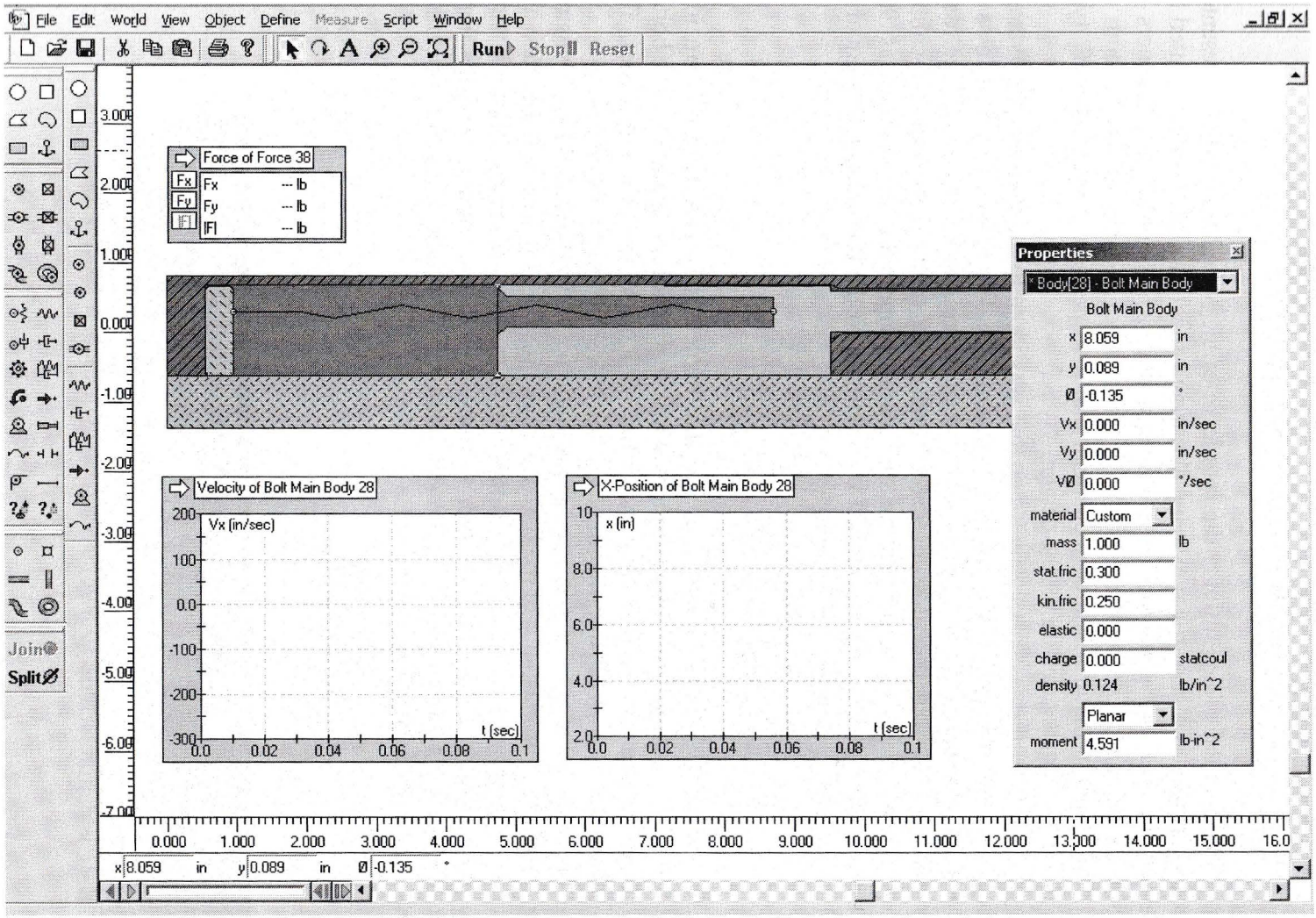
For the purpose of this analysis, the force that was input to the bolt was the average impulse from the pressure-versus-time curve over its duration. While the program allows us to input the actual pressure (force)-versus-time curve of the round, using the average force is quicker and easier. From the pressure-versus-time curve of the 230-grain .45-caliber bullet presented earlier, we calculated that the total impulse supplied to the system was .955 lbs/sec. Therefore, the average force supplied by the round to the bolt rearward is equal to that impulse divided by the time it was applied, or:

$$\frac{.955 \text{ lb/sec}}{.0012 \text{ sec}} = 795.8 \text{ lbs}$$

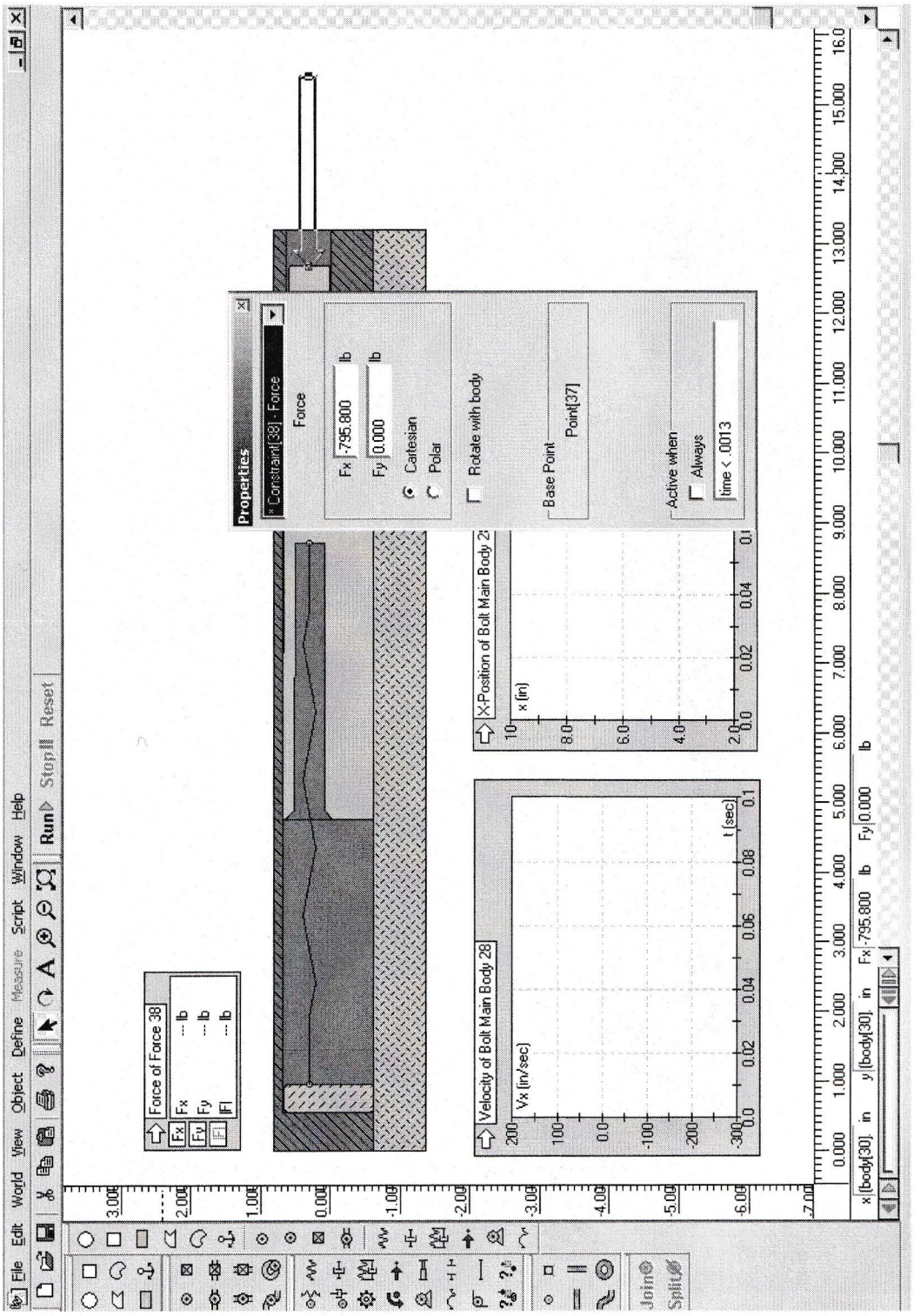
Below is the "Working Model" part file that depicts the M1A1 gun system in a simplified form. The receiver and bolt are modeled in a sectional representation. The bolt is allowed to slide between the receiver and the frame without the use of a keyed slot. The receiver buffer at the rear will absorb the impact of the bolt and dampen its return.

The bolt and all the components were given static friction values of .30 and dynamic friction values of .25. The elasticity of the buffer was initially set at 0. The bolt, because it is modeled as two components, had its weight split between the two pieces. The bolt main body's weight was set at 1.0 lbs, and the bolt section's weight was input at .863 lbs, for a total of 1.863 lbs. This total weight is the combination of the bolt, extractor, operating handle, and a third of the recoil spring weight.

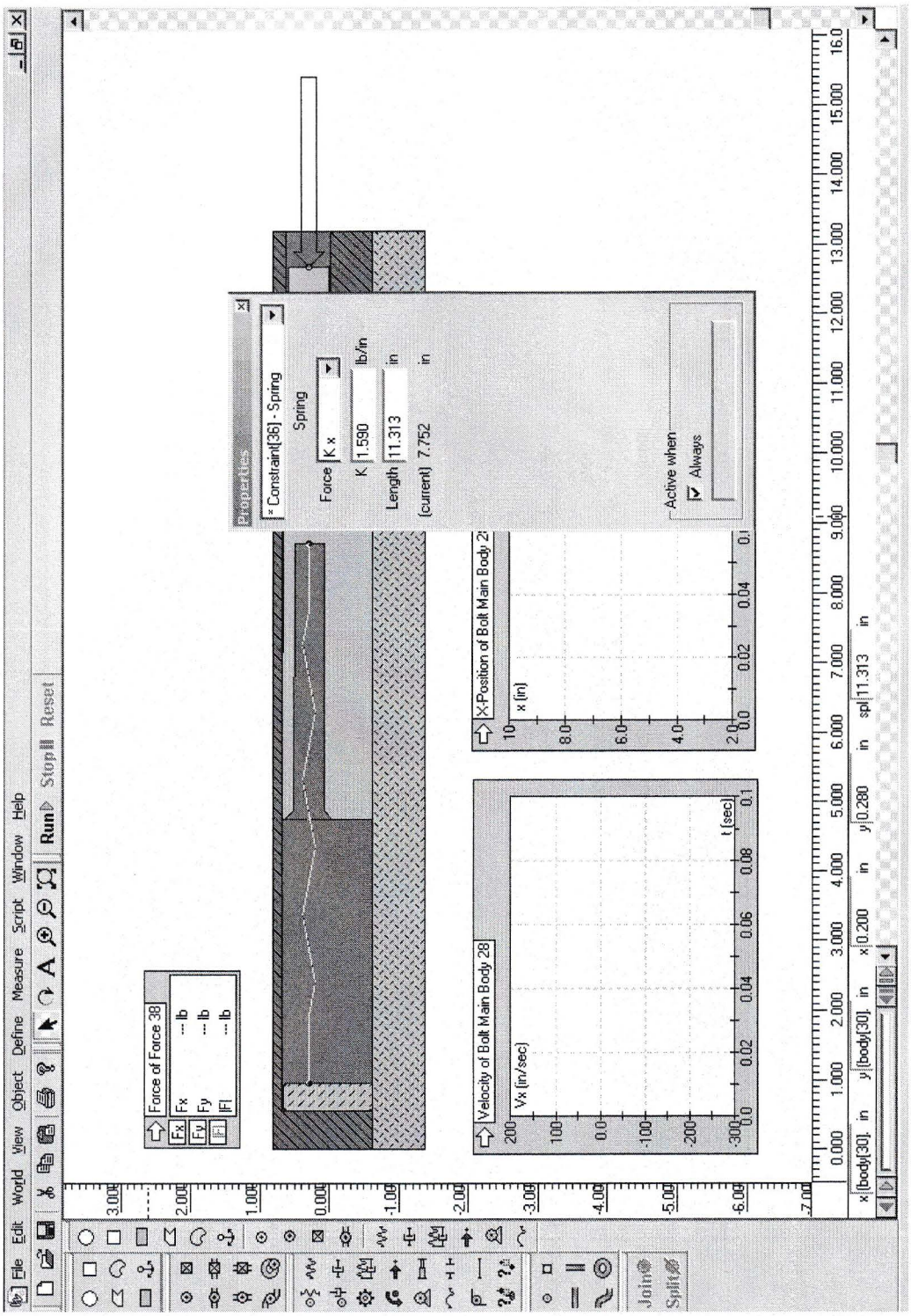



File Edit World View Object Define Measure Script Window Help
Run Stop Reset
Force of Force 38
Fx --- lb
Fy --- lb
|F| --- lb
Velocity of Bolt Main Body 28
Vx (in/sec)
t (sec)
X-Position of Bolt Main Body 28
x (in)
t (sec)
Properties
* Body[28] - Bolt Main Body
Bolt Main Body
x 8.059 in
y 0.089 in
Ø -0.135 °
Vx 0.000 in/sec
Vy 0.000 in/sec
VØ 0.000 °/sec
material Custom
mass 1.000 lb
stat.fric 0.300
kin.fric 0.250
elastic 0.000
charge 0.000 statcoul
density 0.124 lb/in^2
Planar
moment 4.591 lb-in^2
Join
Split
x 8.059 in y 0.089 in Ø -0.135 °

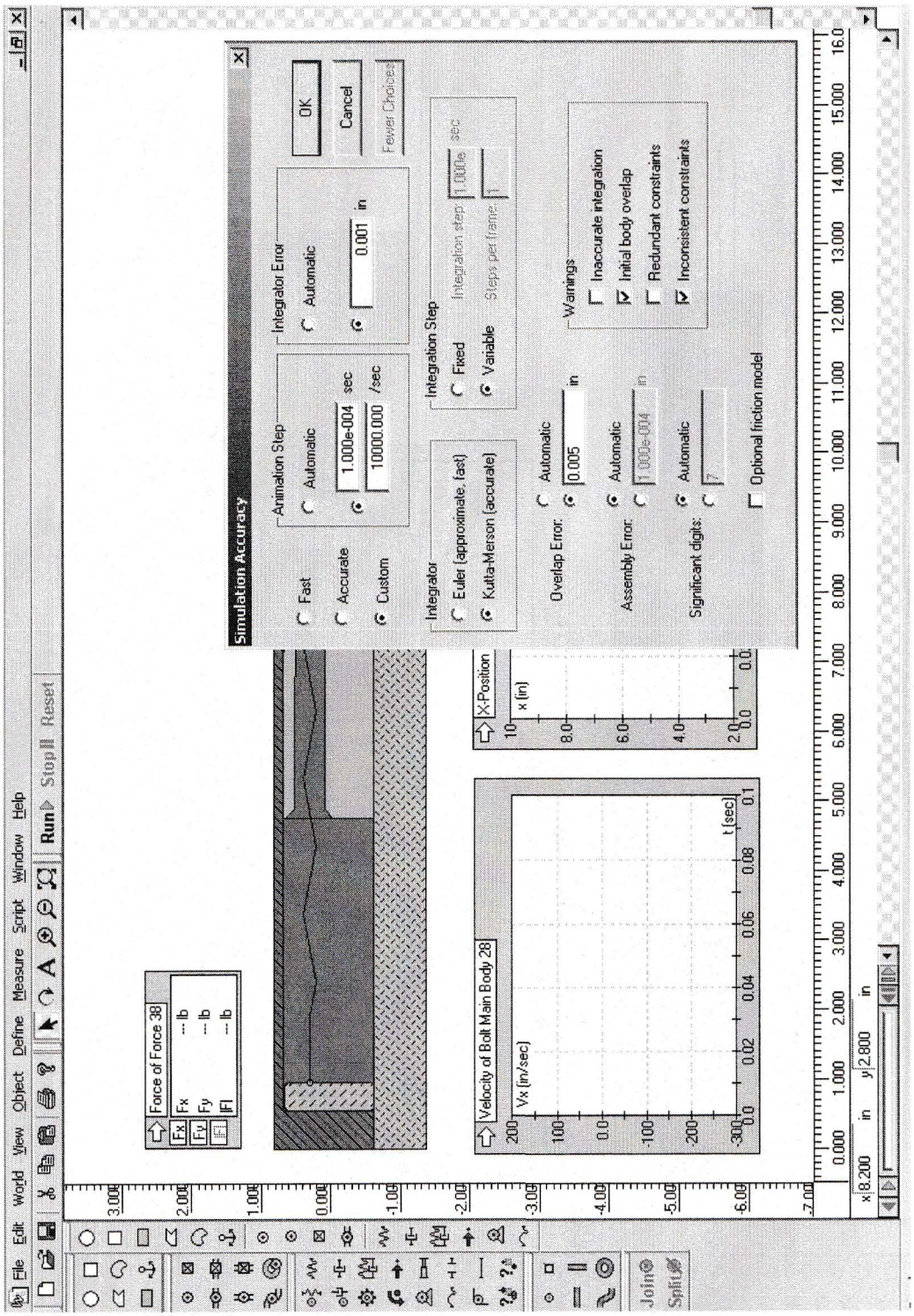
The force of 795.8 lbs is applied only for the first .0012 sec to achieve the impulse of .955 lbs/sec from the .45-caliber round.



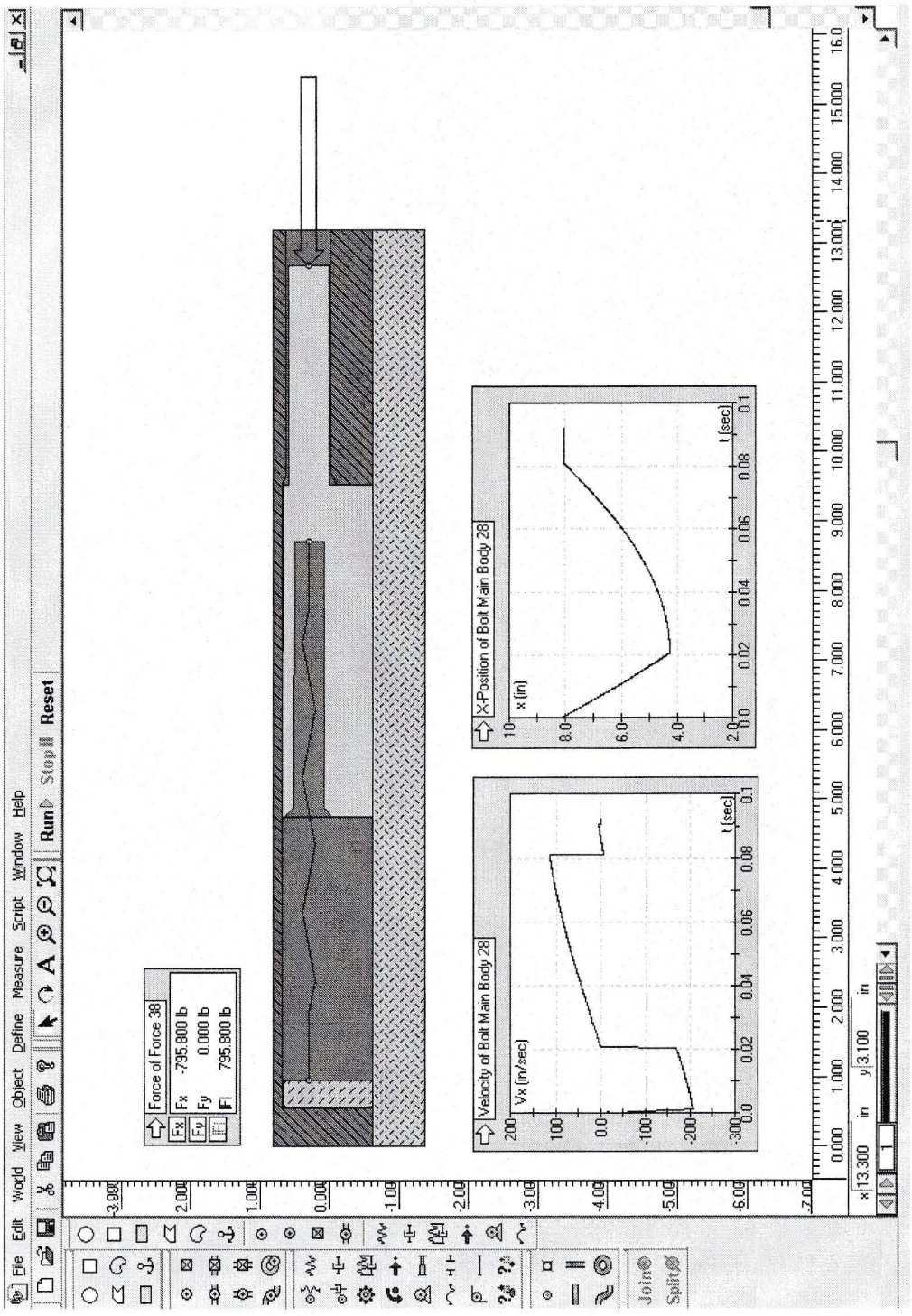
The action spring's spring rate of 1.59 lbs/in and free length's input of 11.313 inches are shown.



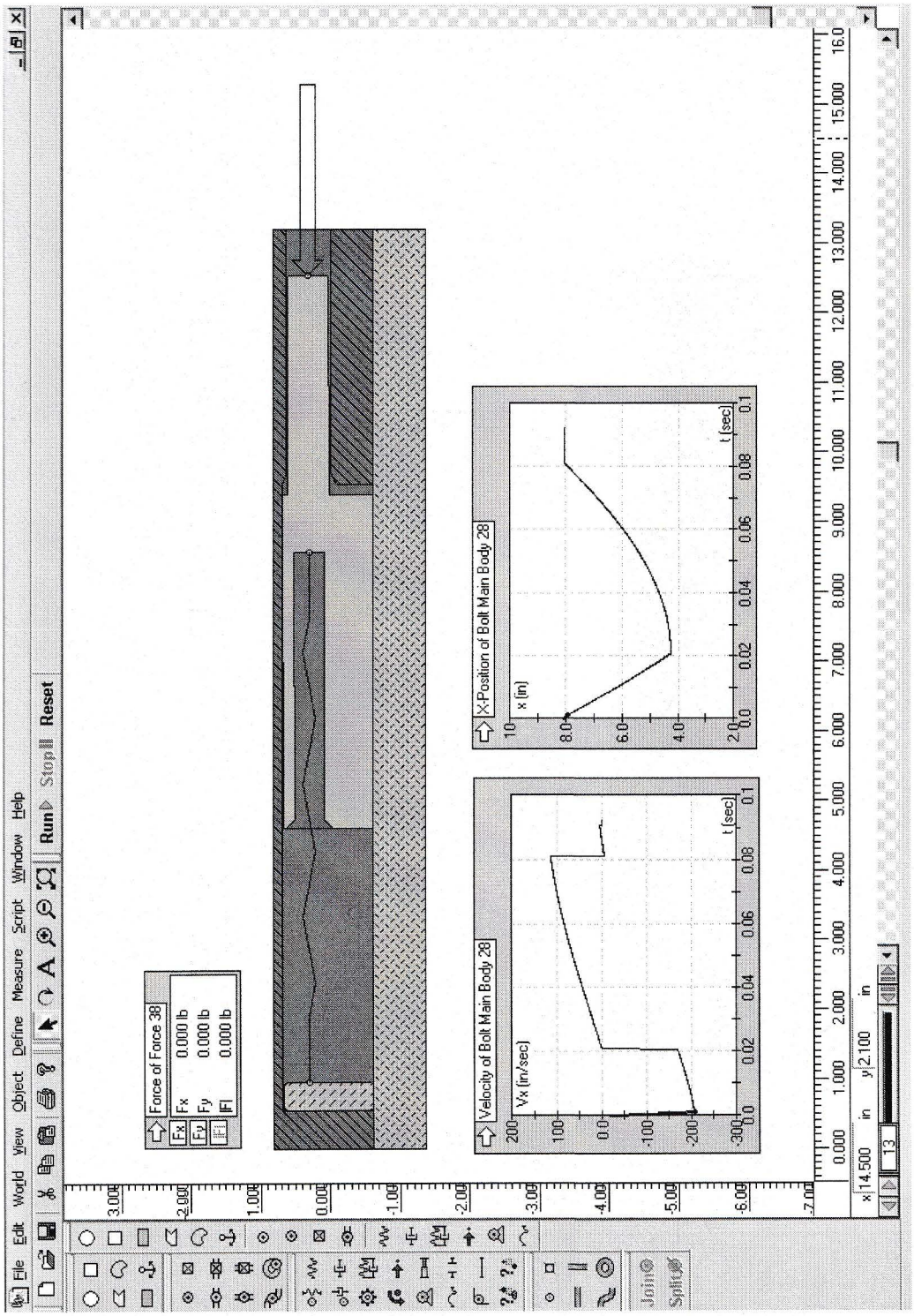
The time step used for the calculation of each frame was set to .0001 sec.



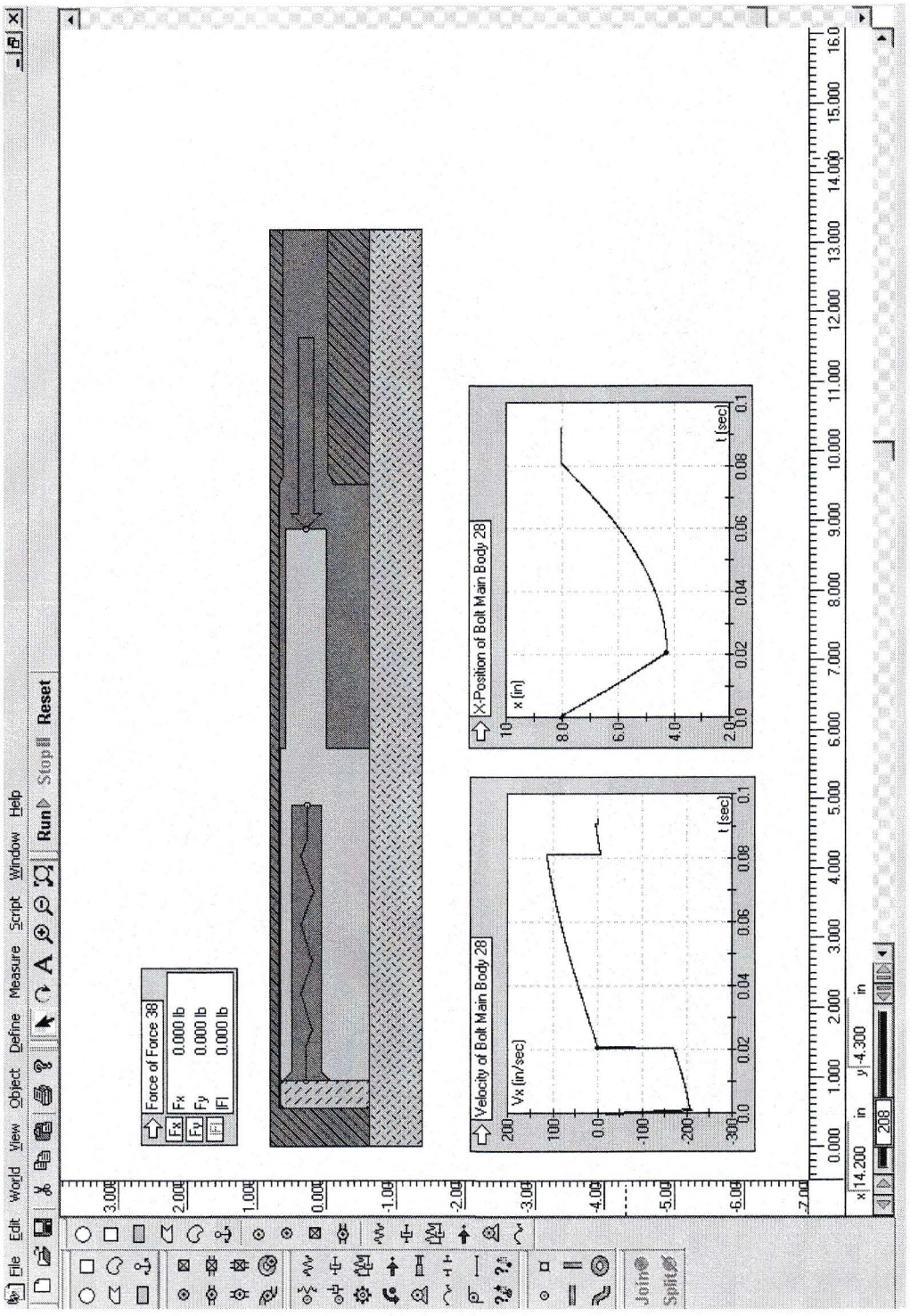
When the analysis was run, the following results were obtained:
At frame one, the force has been applied to the bolt, and the bolt has started its movement to the rear.


File Edit World View Object Define Measure Script Window Help
Run Stop Reset
Force of Force 38
Fx -795.800 lb
Fy 0.000 lb
|F| 795.800 lb
X-Position of Bolt Main Body 28
x (in)
t (sec)
Velocity of Bolt Main Body 28
Vx (in/sec)
t (sec)
x 13.300 in y 3.100 in

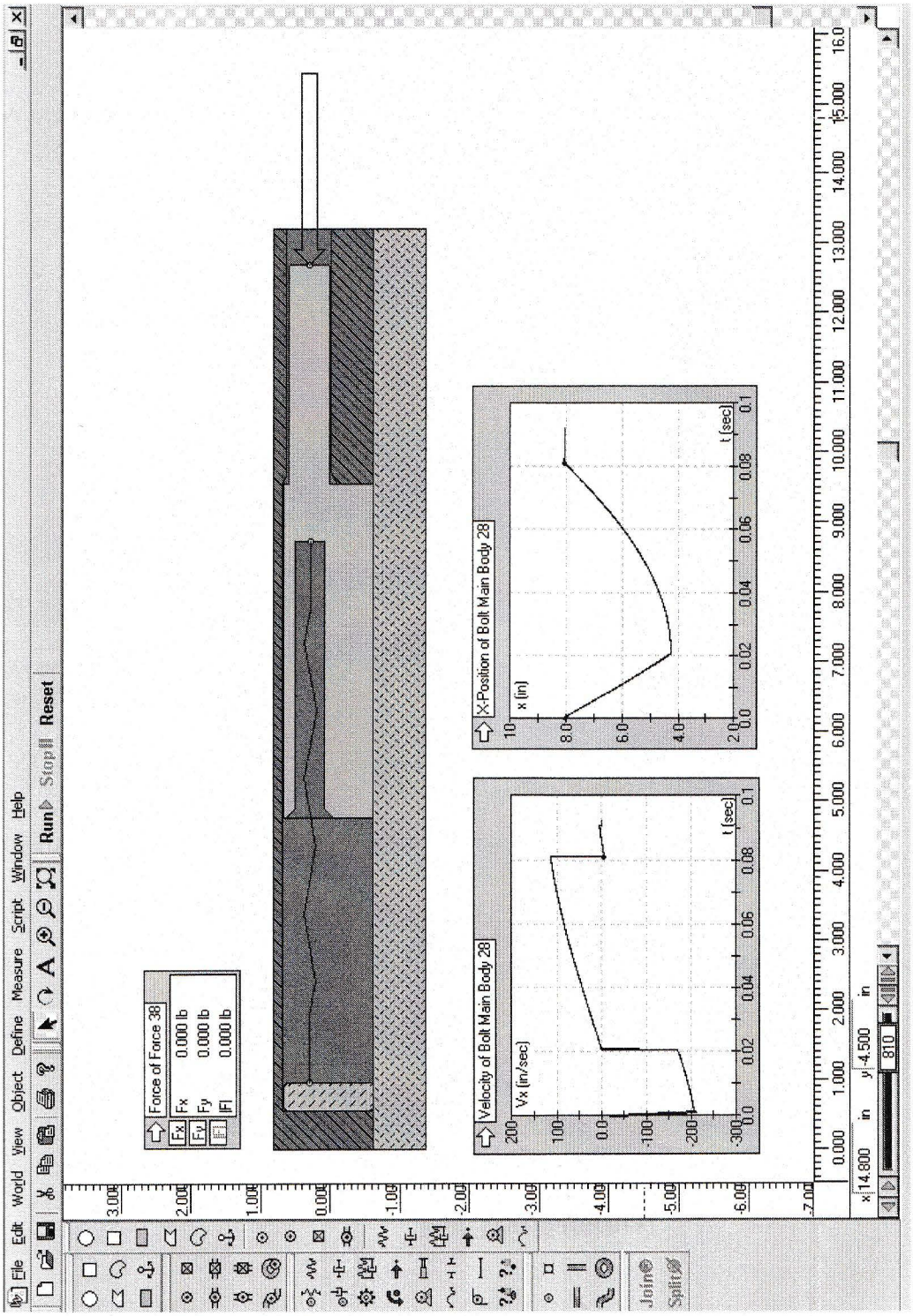
At frame thirteen (.0013), the force is now off, as required.



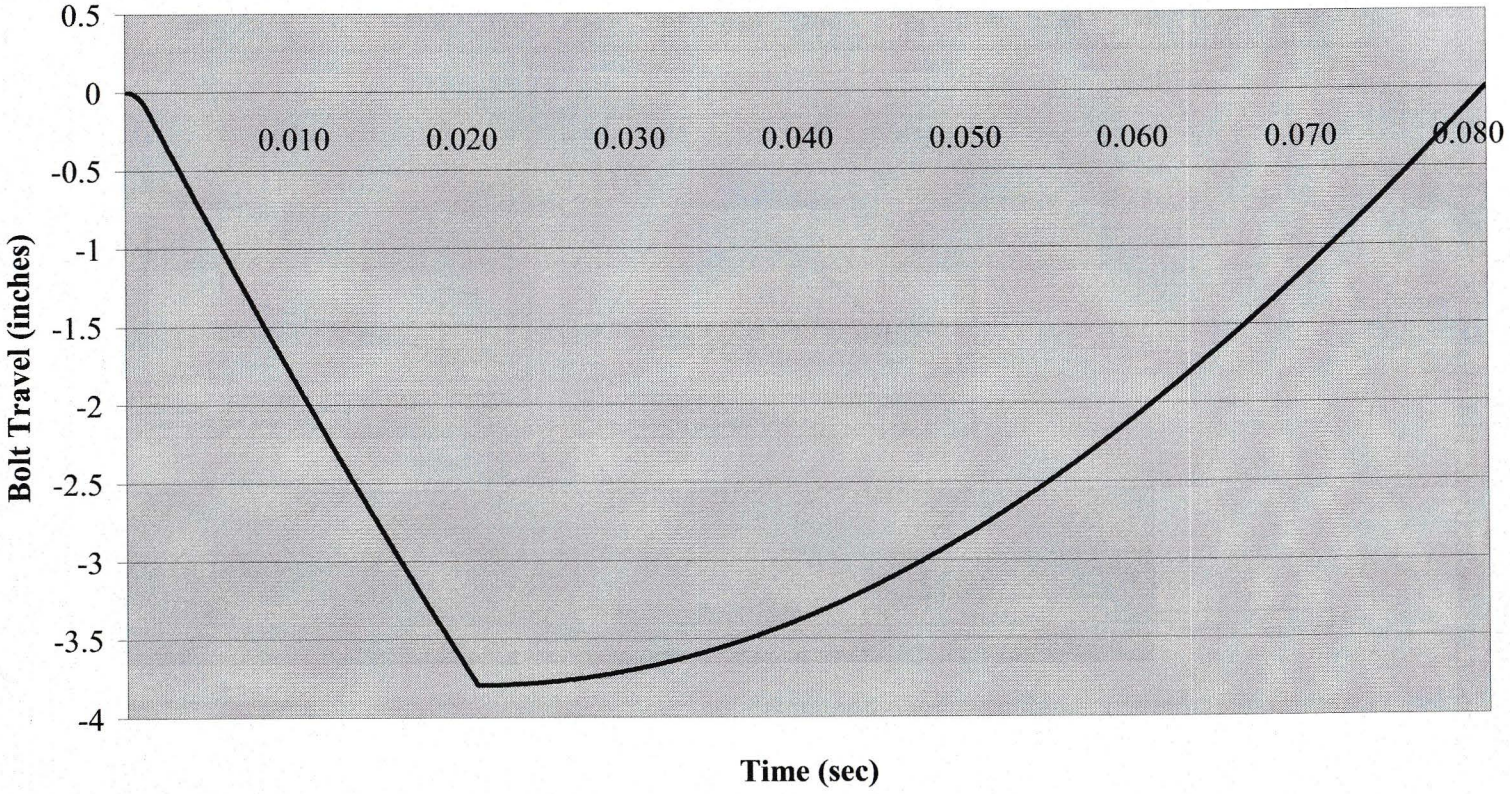
Frame 208 (.0208 sec) shows that the bolt has reached the rear of the receiver and has made impact with the buffer. The bolt reaches a maximum velocity of 208 in/sec and its velocity at impact is 168 in/sec.



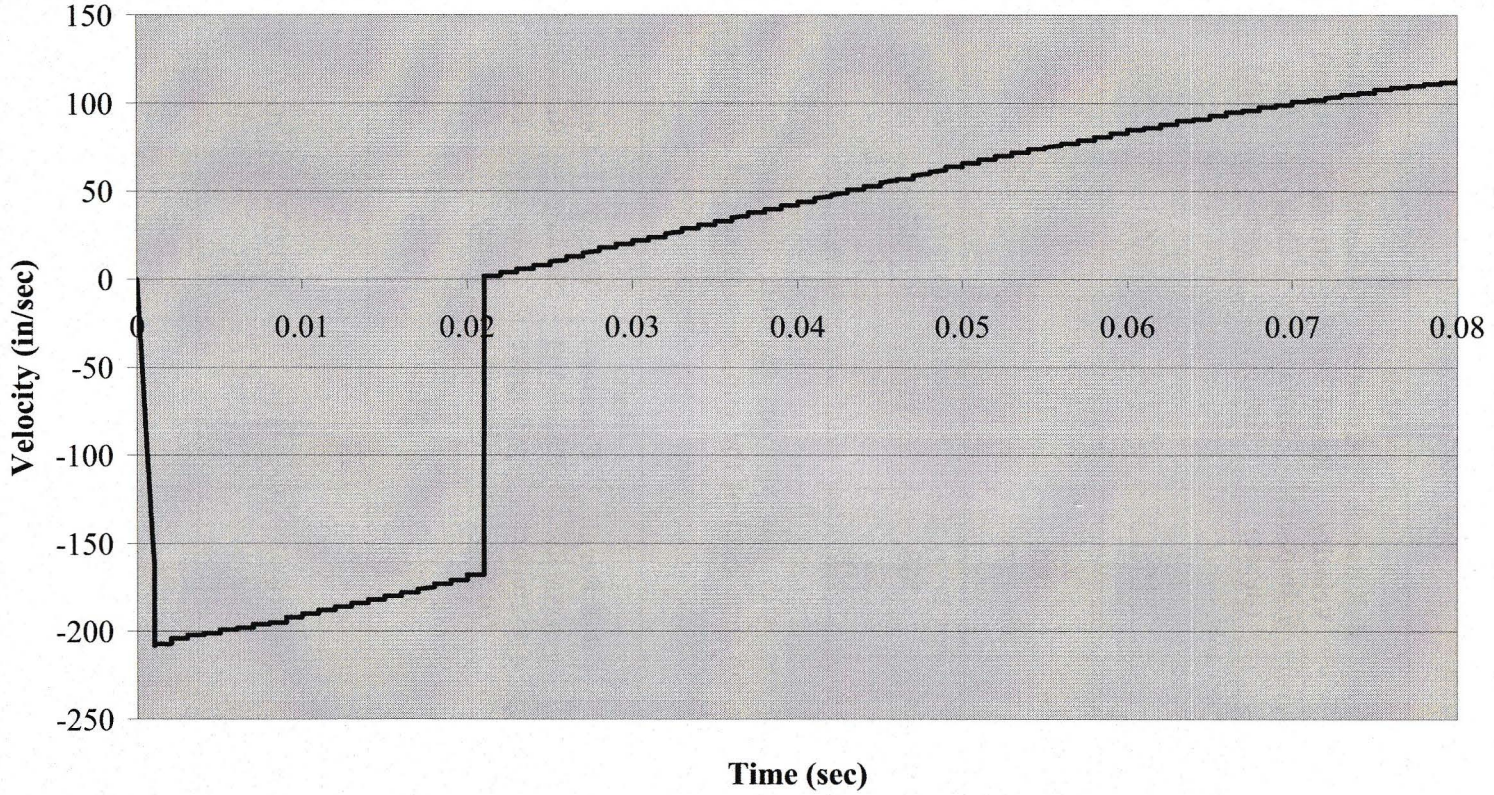
The bolt now is forced forward by the spring, returns to the front of the receiver at .081 sec, and impacts at a velocity of 114 in/sec.



M1A1 Bolt Travel
Working Model Analysis
Elasticity = 0



M1A1 Bolt Velocity
Working Model Analysis
Elasticity = 0



Several simulation runs were done by changing the elasticity of the rear receiver buffer and bolt with the following results:

Analysis	Bolt Recoil Velocity @ Impact (in/sec)	Bolt Counter-Recoil Vel @ Impact (in/sec)	Recoil Stroke Time (sec)	Counter-Recoil Time (sec)	Total Stroke Time (sec)	rpm Level
Working Model Simulation—Includes Frictional Losses Buffer Elasticity = 0	168	114	.021	.060	.081	741
Working Model Simulation—Includes Frictional Losses Buffer Elasticity = .1	168	115	.021	.055	.076	789
Working Model Simulation—Includes Frictional Losses Buffer Elasticity = .15	168	116	.021	.050	.071	845

As you can see with this analysis as well, the coefficient of restitution has a significant effect on the rpm level of the gun. A summary of all three analysis techniques presented is shown below:

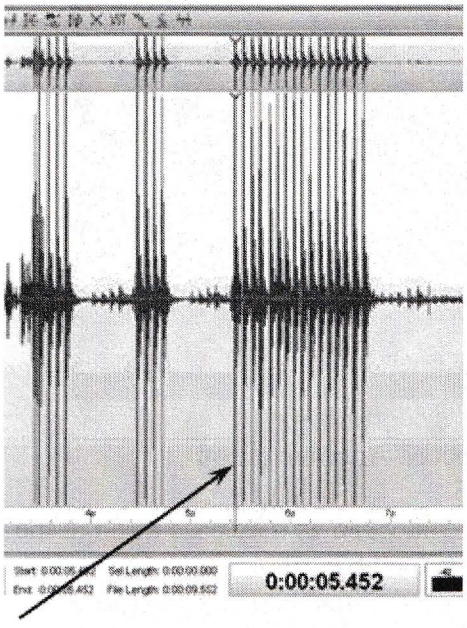
Analysis Type	Bolt Recoil Velocity @ Impact (in/sec)	Bolt Counter-Recoil Vel @ Impact (in/sec)	Recoil Stroke Time (sec)	Counter-Recoil Time (sec)	Total Stroke Time (sec)	rpm Level
Calculated Using Impulse – No Friction	198	234	.0383	.0327	.071	849
Calculated Using Conservation of Energy - Includes Frictional Losses Buffer Elasticity = 0	168	114	.021	.060	.081	742
Working Model Simulation - Includes Frictional Losses Buffer Elasticity = 0	168	114	.021	.060	.081	741

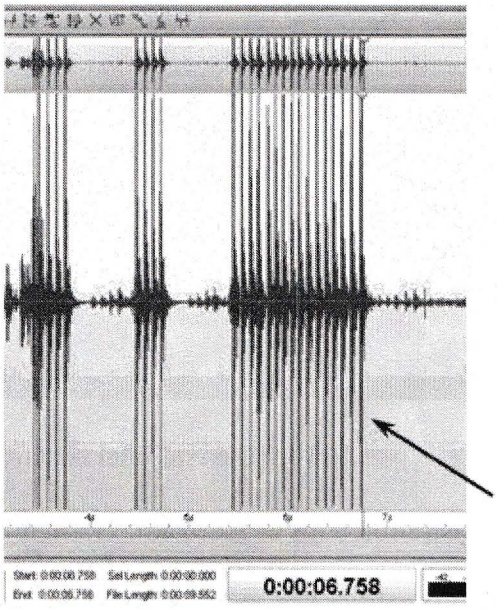
There is very good correlation between the two analyses that include frictional effects but how do they compare with actual published M1A1 rpm values and experimental results.

Reported M1A1 Round-per-Minute Values versus Calculated

rpm Value	Source of Information
700	Nelson, Thomas B., *The World's Submachine Guns*, T.B.N. Enterprises (1963), p.66
600	Dunlap, Roy F., *Ordnance Went Up Front*, Samworth Press (1948), p. 299
610	US Government, *First Report on Sten Sub-Machine Gun 9mm / MkII*, Ordnance Program 5082, Aberdeen Proving Ground (Jan. 6, 1942), p.11
846	Calculated Using Impulse – No Friction
742	Calculated Using Conservation of Energy and Includes Frictional Losses. Elasticity = 0
741	Working Model Simulation Using Impulse and Includes Frictional Losses. Elasticity = 0

There is some disparity between available published results and the calculated results are higher yet. A recording of an M1A1 firing full auto was obtained and analyzed using WavePad Sound Editor Software. Firing start occurred at time 5.452 sec and ended at 6.758 sec. During this duration of 1.306 seconds, 15 rounds were fired. This yields an actual experimental rpm level of 689 rounds per minute and is within 7.5% of the theoretical calculated results that include friction.





From the National Archives and Record Administration
111-SC-195695
Registration slips of these two German women are checked as they pass through the outskirts of Monschau, Germany. October 1944.
This soldier has an M1A1 Thompson with a reinforcement band on the forend.

Chapter 5
Oval Spring Design for Magazine Springs

Oval compression springs are generally used in magazine spring design for their consistent loading, space considerations, and cost. Oval springs can be manufactured readily on spring machines with the use of special attachments. Generally, the sides of the magazine stabilize the buckling of the spring and the magazine follower guides the spring as it is compressed.

Standard compression and extension spring design formulas may be used for designing oval springs if a stiffness correction factor Z is employed.[1] This stiffness correction factor is based on the ratio of the inside length dimensions of the oval spring, where D is the smaller inside width and D' is the larger major inside length. The stiffness correction factor may be calculated from the following formula:

$$Z = (D'/D)^{-2.1}$$

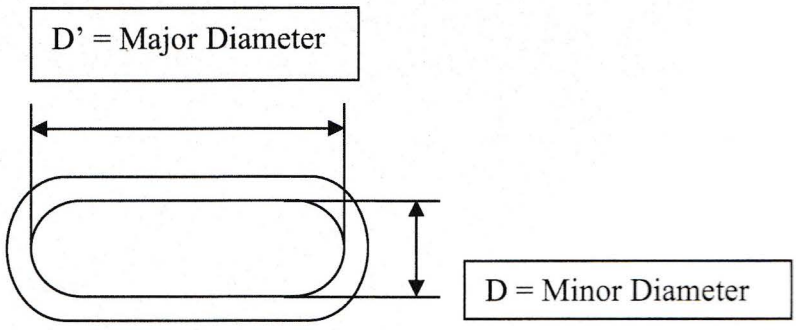
The spring rate can then be calculated as $K = P/X = \frac{Gd^4Z}{8ND^3}$ (lbs/in)

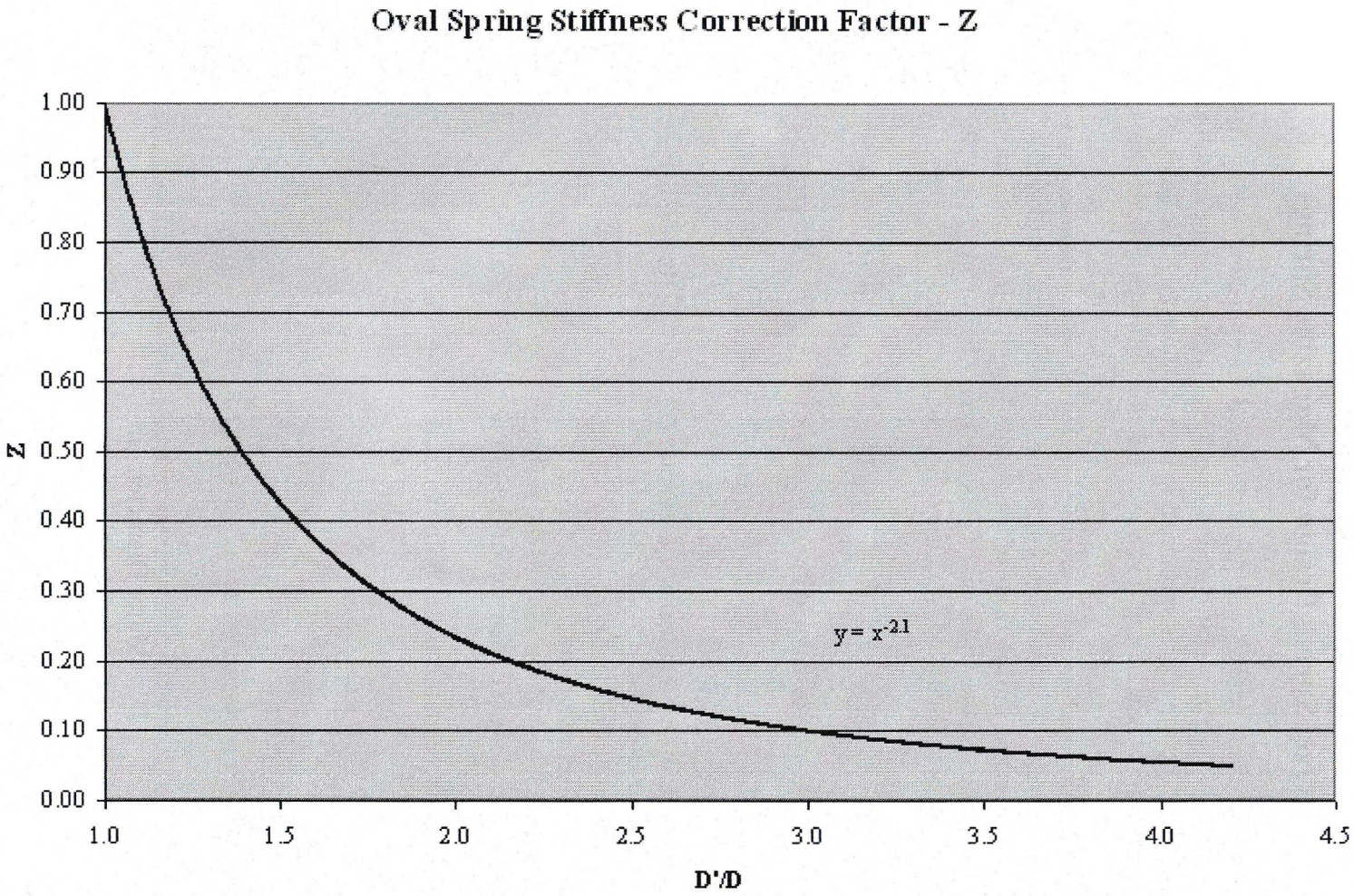
Where:
N is the number of active coils
G is the torsion modulus in pounds per square inch (11.5×10^6) for music wire
d is the wire diameter in inches
P is the spring load in pounds (lbs)
X is the spring displacement in inches
D' is the large inside length dimension of the spring
D is the smaller inside length dimension of the spring

To find the stress concentration factor R for an oval spring, use D/d, not D'/d, as the spring index. $C = D/d$

Then $R = \frac{4*C-1}{4*C-4} + \frac{.615}{C}$

The stress in the spring is calculated as $S = \frac{8PD'R}{\pi d^3}$ (psi)




Oval Spring Stiffness Correction Factor - Z
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Z
y= x-2.1
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
D'/D

These formulas were used to analyze the M1A1's magazine spring with the following results:

Oval Spring Design Program
M1A1 Magazine Spring

Input Variables:

Major Inside Spring Dimension Length =	0.977
Minor Inside Spring Dimension Length =	0.642
Number of Active Coils =	20.0
Number of Total Coils =	20.0
Spring Wire Diameter =	0.054
Torsional Spring Modulus G =	11,500,000
Spring Free Length =	13.500
Initial Load Length L1 =	8.30
Final Load Length L2 =	1.20
Max. Stress for the Wire Diameter Selected =	301,100

Calculated Values:

D'/D =	1.5
Stiffness Correction Factor Z =	0.41
Wahl C Value =	11.889
Stress Correction Factor R =	1.121
Spring Rate K in lbs/in =	1.0
Load at L1 in Pounds =	5.0
Load at L2 in Pounds =	11.8
Stress at L1 in psi =	88,000
Stress at L2 in psi =	208,300
Solid Height in inches =	1.134
Solid Load in pounds =	11.8
Solid Stress in psi =	209,400
Solid Stress as a % of Max Stress =	70%
Stress at L2 as a % of Max Stress =	69%

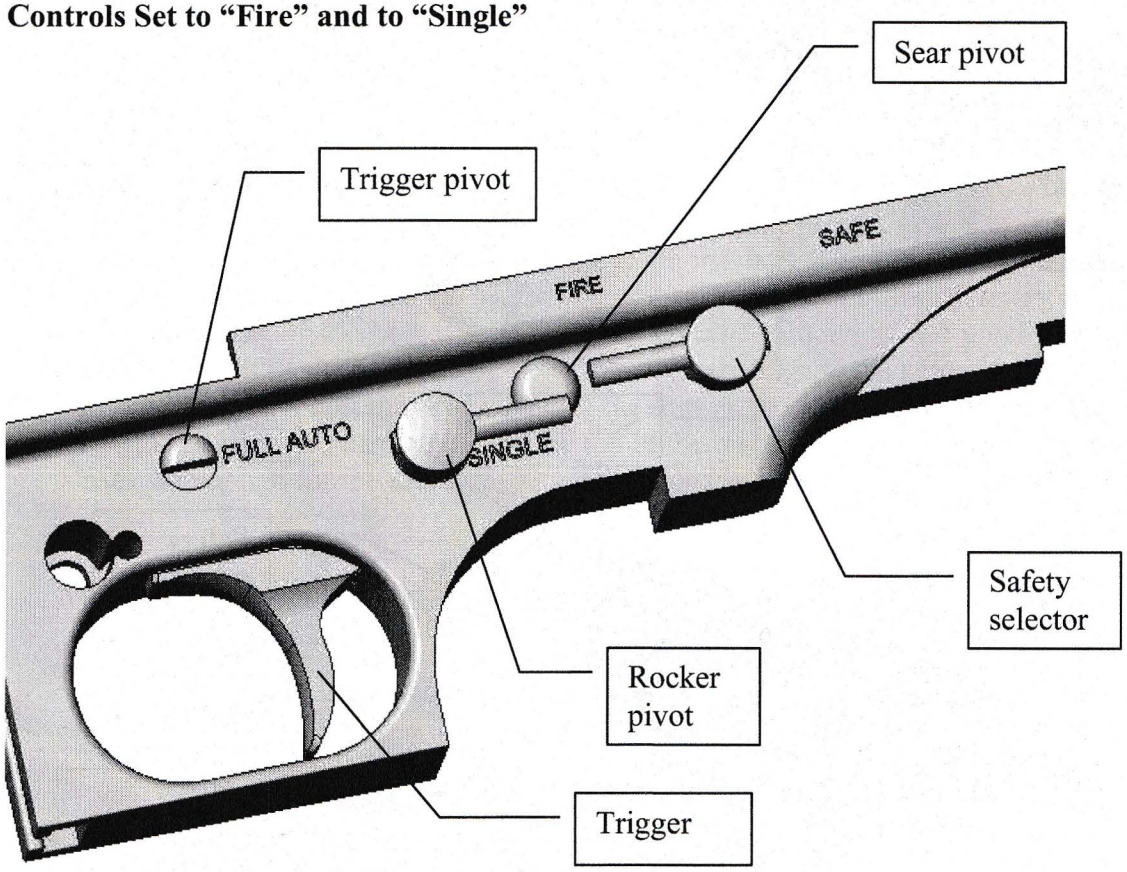
Spring will take a set.

From the National Archives and Record Administration
111-SC-214471
Chinese fighting men with their Tommy guns take training on the range. January 1945.

Chapter 6
Cycle of Operation

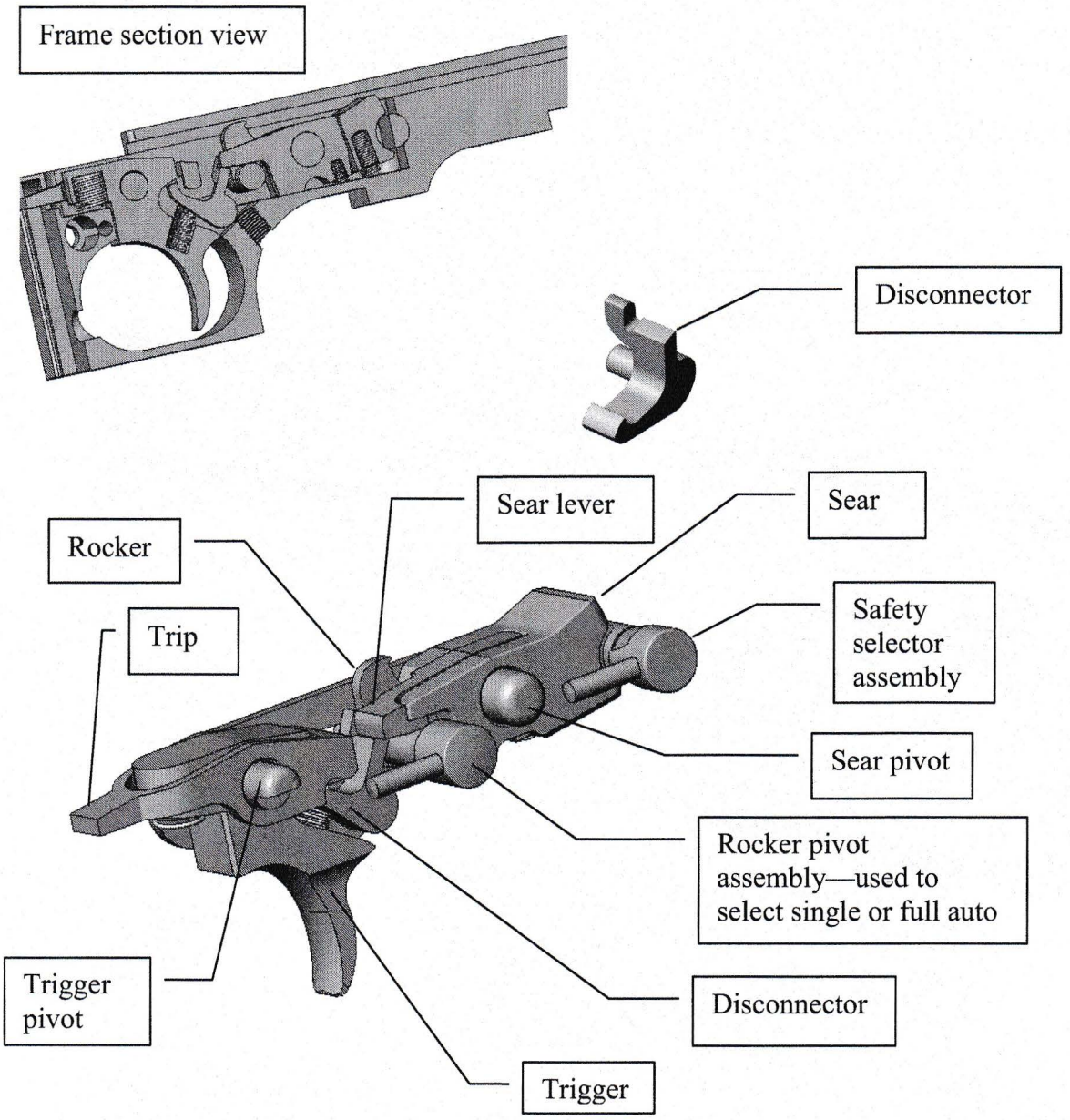
To fire the Thompson submachine gun in single-fire (semi-automatic) mode, the rocker pivot must be set to "Single" fire, and the safety selector must be set to the "Fire" position. The bolt must also be to the rear and held on the sear as the Thompson fires from the "open bolt" position. Squeezing the trigger in this mode will fire one round, and it is necessary to squeeze and release the trigger each time for a single round to be fired.

Controls Set to "Fire" and to "Single"



When the trigger is squeezed, the trigger rotates around the trigger pivot (the forward pin of the pivot plate), and in so doing lifts the disconnector upward. The disconnector has a round boss that mates with the trigger, and this keeps the parts together as they rotate. The upward movement of the disconnector lifts the sear lever. The sear lever rotates on the sear pivot and is contained in a slot provided for it in the sear. Lifting the sear lever also lifts the front end of the sear, as the parts are mated to

rotate vertically. This rotation of the sear and sear lever is resisted by the sear spring and the sear lever spring. When the safety is in the "Fire" position, the sear rotates through the safety selector opening machined in the part. The rotation of the sear around the sear pivot (the rear pin of the pivot plate) causes the rear portion of the sear to disengage from the sear notch on the underside of the bolt.

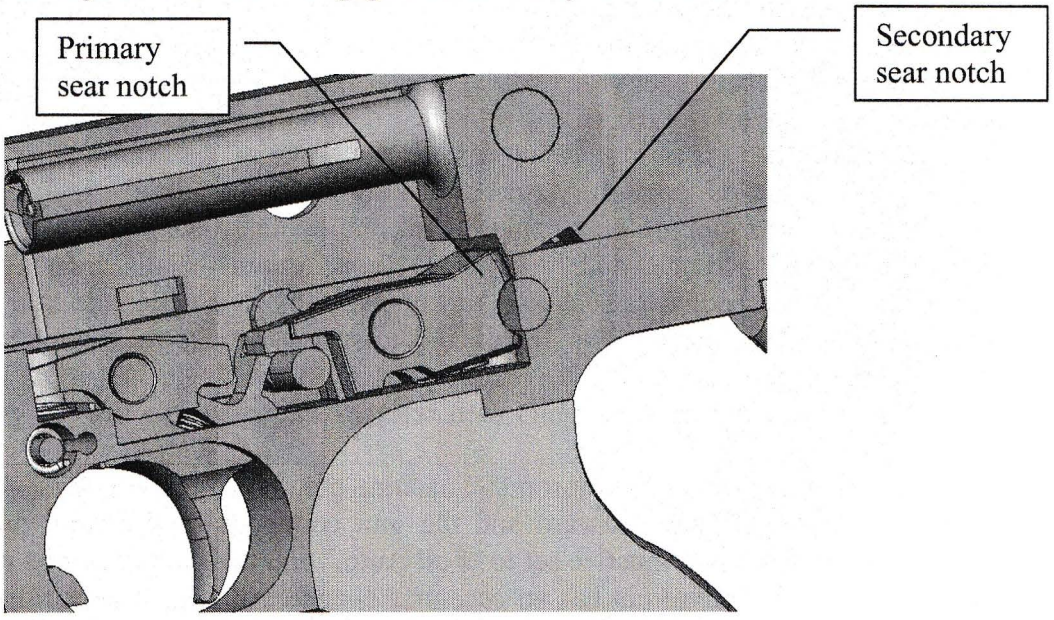


When the sear rotates far enough, the bolt is released off the sear, and it moves forward under pressure from the recoil spring. "After the bolt moves forward about 1 inch, the forward end of the bolt comes in contact with the back of the cartridge and pushes it forward until the nose of the bullet comes in contact with the bullet ramp of the

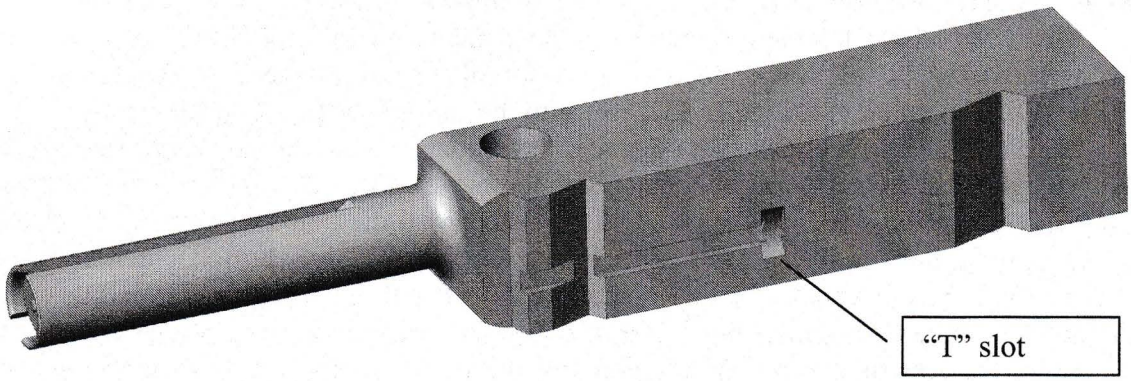
receiver."[1] The cartridge is guided into the chamber of the barrel first by the lips of the magazine, which hold and control the feeding round. After the bolt moves forward enough for the magazine lip to release the round, the bullet feed ramp of the receiver takes over to guide the round into the chamber of the barrel. As the cartridge is being seated in the barrel chamber, the extractor snaps around the rim of the cartridge, and the round is fired by the fixed firing pin protrusion on the bolt face of the M1A1.

As the cartridge is fired, the pressure of the powder gases climbs rapidly and acts against the empty cartridge case, forcing the bolt rearward against the recoil spring. The extractor holds the empty case against the face of the bolt as the bolt moves rearward.

> After the bolt has traveled to the rear about 2 inches, the ejector, which protrudes in a groove on the left side of the round portion of the bolt, comes in contact with the base of the empty cartridge and throws it to the right through the ejection port of the receiver. The bolt still has about one and three-quarter inches to go to the rear before the back of the bolt comes in contact with the buffer. The rearward movement of the bolt compresses the recoil spring and it slows down the bolt's motion. The bolt in most conditions will travel far enough to impact the receiver buffer which absorbs the final impact shock. On the underside of the bolt there are two forward sear notches. If the bolt strikes the buffer, the sear will engage the front primary notch. If the movement of the bolt is retarded and the bolt velocity is not great enough to cause the bolt to strike a buffer, the sear will likely engage the secondary rear notch of the bolt. If the bolt moves to the rear far enough to eject the empty cartridge case and to feed the next cartridge from the top of the magazine, the bolt will normally be back far enough for the sear to engage the secondary rear notch.[2]



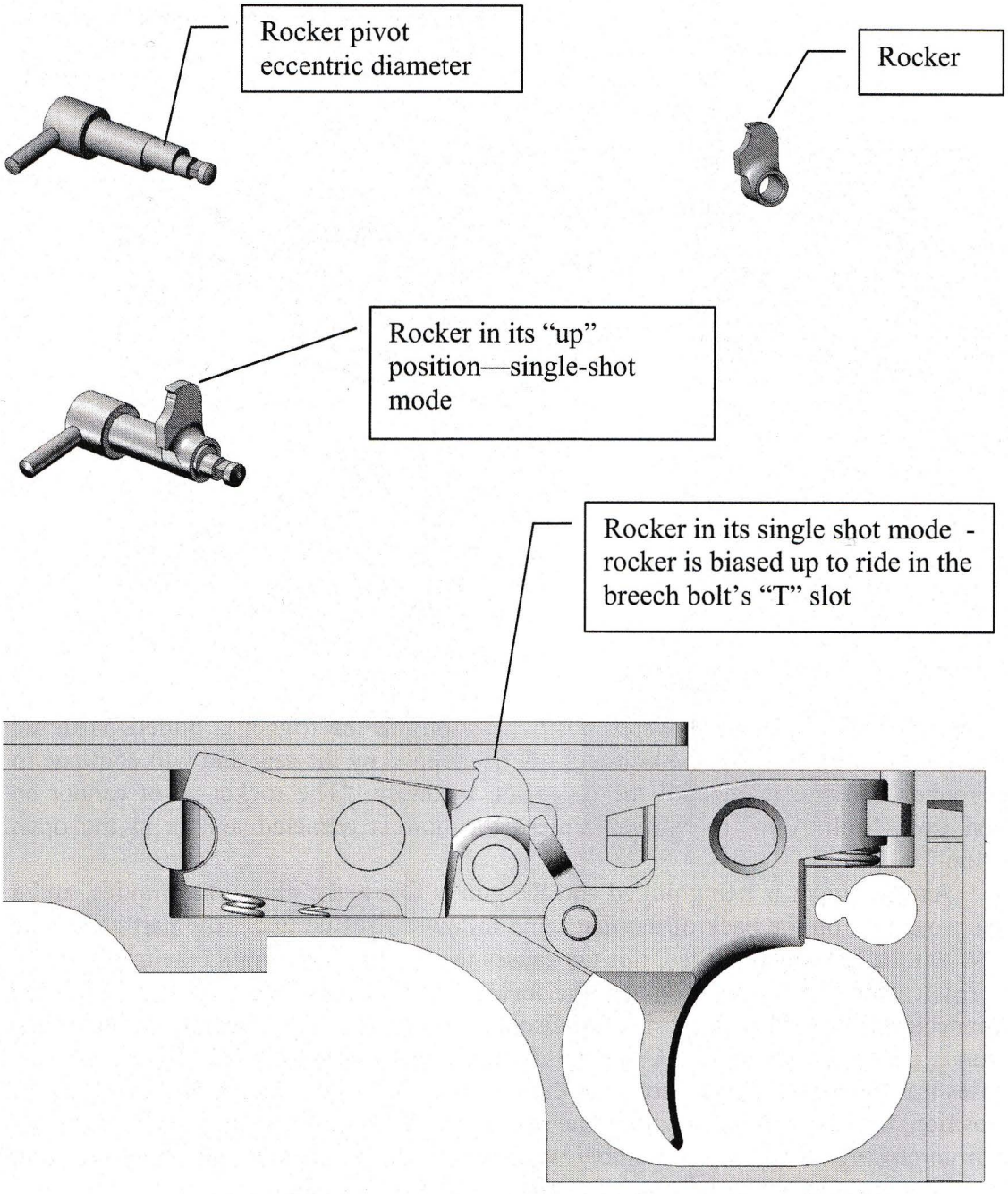
The engagement of the sear with the bolt is also governed by whether the rocker is in its upward position or in its retracted position, away from the bolt. In single-shot mode, the top point of the rocker moves into the "T" slot groove on the underside of the bolt and rides in this track as the bolt moves forward or rearward. When the point of the rocker contacts the rear end of the bolt's "T" groove, during the bolts forward movement, the rocker is rotated forward.

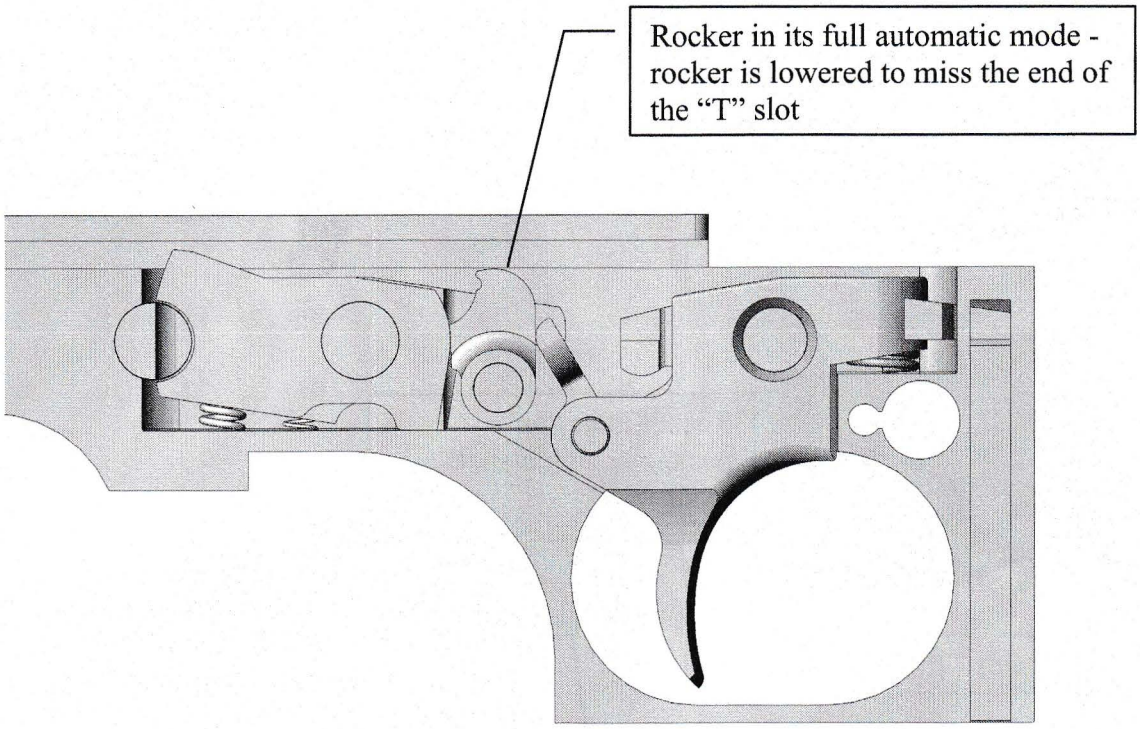


This rotation causes the rounded top part of the rocker to come in contact with the disconnector and forces the disconnector out from under the sear lever. As soon as the disconnector has been disengaged from the sear lever, the sear spring biases the rear portion of the sear up. As the bolt is propelled back in the receiver, hits the buffer, and starts to return, the sear will rotate upward to catch one of the sear notches of the bolt. This stops the bolt from going forward again and prevents full automatic fire.

In order for the gun to be fired again, the operator must release the trigger to allow the trigger to rotate, and in so doing, bring down the disconnector. Once the disconnector comes down far enough, it will rotate by and under the sear lever. This rotation of the disconnector also forces and rotates the rocker rearward back into its ready position to be contacted by the bolt for the next single-fire shot. The process repeats as long as the operator pulls then releases the trigger to fire the gun for each trigger pull.

In order to fire the Thompson submachine gun in full automatic mode where the operator pulls the trigger rearward and the gun continues to fire until the trigger is released, the rocker pivot must be set to "Full Auto," and the safety must be in the "Fire" position. The rocker pivot pin has an eccentric diameter that the rocker rides on. When the rocker pivot is set at "Full Auto," the rocker is lowered enough to clear the "T" slot in the bolt and is not touched by the bolt as it moves forward or rearward. In this position, the rocker will not be rotated against the disconnector, which, in turn, will not disengage it from the sear lever.


Rocker pivot eccentric diameter
Rocker
Rocker in its "up" position—single-shot mode
Rocker in its single shot mode - rocker is biased up to ride in the breech bolt's "T" slot

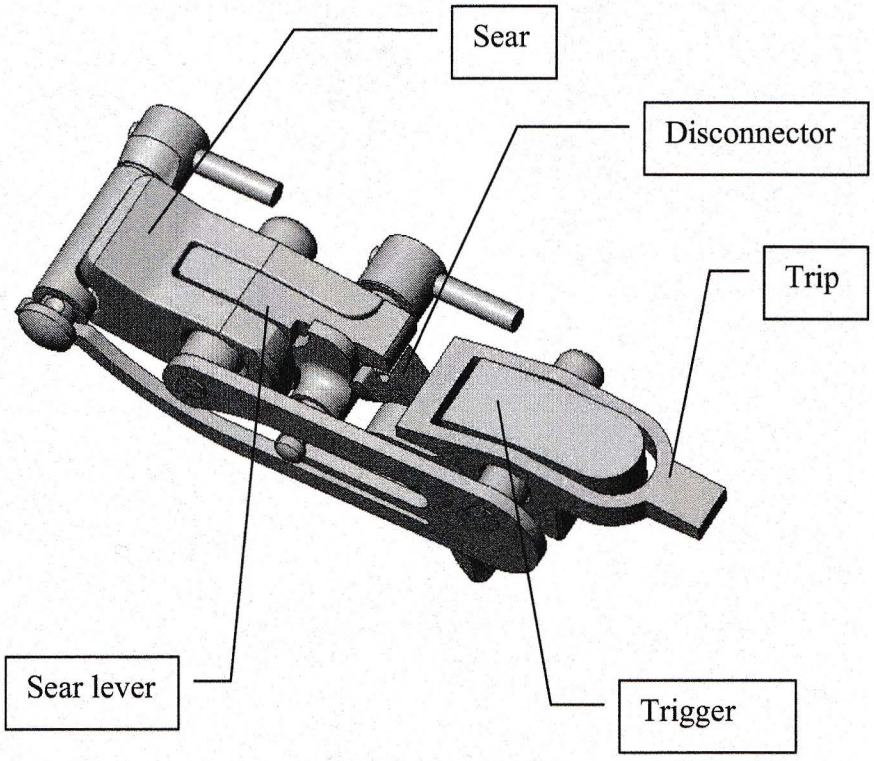


The sear then remains in its lowered position as long as the trigger is pulled. With the sear in the lowered position, the bolt will not be stopped by the sear and will continue to feed rounds and fire them until the magazine is empty. "The rocker pivot cannot be turned from 'Full Auto' to 'Single' unless the bolt is retracted and is in the open position,"[3]

As the trigger is being pulled and the gun is firing, the magazine empties, and a metal projection on the back of the magazine follower rises up under the part called the trip. When the last round is fired, this tab causes the trip to rotate around the trigger pivot pin. This rotation of the trip contacts the forward part of the disconnector, rotating the disconnector as well as compressing the disconnector spring. The disconnector is rotated so that it clears the sear lever. Once the disconnector releases the sear lever, this also releases the sear, and the rear portion of the sear can rise. With the rear of the sear in the up position, the bolt will be caught by the sear and will not go forward. This prevents the bolt from closing on an empty chamber when the magazine is empty and keeps the bolt in the ready position, waiting for another magazine of ammunition.

The safety operation of the Thompson submachine gun is fairly straightforward. The safety blocks the movement of the sear. When the safety lever is turned toward the front, or "Fire" position, a flat, milled surface is positioned so that the sear is allowed to rotate past the safety selector, which allows the sear to release the bolt. When the safety is turned toward the rear, or "Safe" position, the rounded part of the safety engages in a groove at the rear of the sear, prevents its rotation, and locks it in the up position,

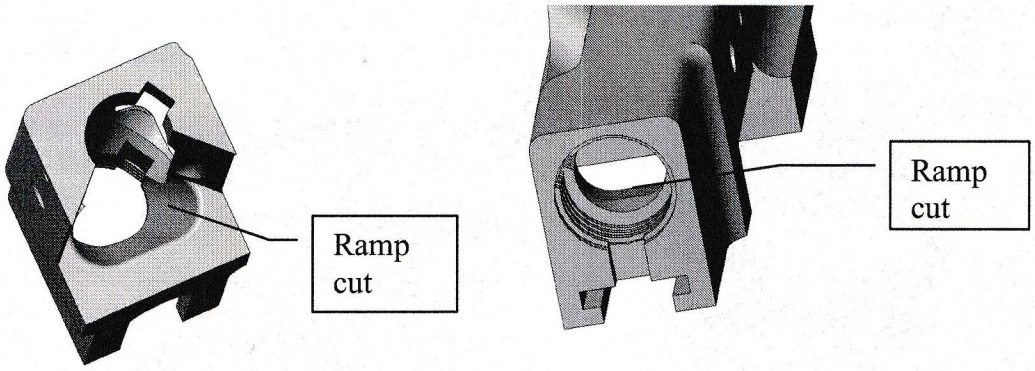
preventing the release of the bolt. The safety of the M1A1 can be operated when the bolt is to the rear or when the bolt is in its forward position. This was not true for earlier Thompson models. If the bolt is forward and the safety is rotated to the "Safe" position, the bolt is locked in the forward position on the M1A1. When the bolt is forward, the rear notch cut in the bolt allows clearance for the rear of the sear to be up. The safety selector rotated to the "Safe" position prevents sear rotation, which, in turn, prevents the bolt from moving rearward.



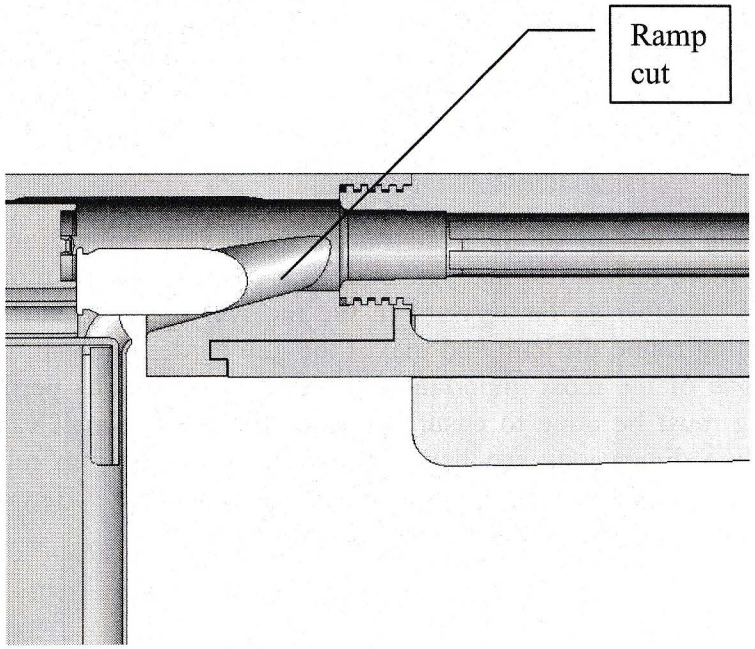
From the National Archives and Record Administration
111-SC-364645
Private Ernest Wilson, 142 Infantry, sips coffee with his M1A1 Thompson after completing a round trip up a mountainside with a mule pack train. December 1943.

Chapter 7
Feed System

One of the Thompson submachine gun's distinguishing characteristics is its feed system. The Tommy gun is different from most other gun designs in that its magazine box is farther back from the mouth of the chamber than it is on most other guns. The Thompson compensates for its magazine position by having a long funnel feature that guides the round up from the magazine to the chamber of the barrel. This feed-ramp feature requires some unique machining and subsequent finishing.

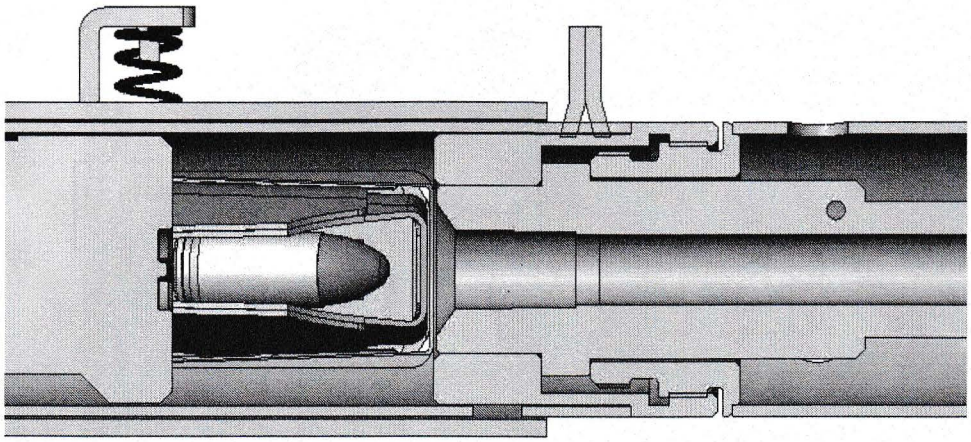


To generate the feed ramp, a cutting tool must enter the front of the receiver at a compound angle and must rotate and sweep the feed-ramp cut at that same compound angle to generate the ramp. In the picture below, the bolt has already stripped the cartridge from the magazine, and the round still has not entered the chamber.



For most other weapon designs, the round from the magazine and the round position are moved close to the chamber to aid feeding. An example of this is another submachine gun design, the STEN. The STEN has a magazine that positions the cartridge closer to the chamber. The magazine holds the round until it just enters the chamber and then releases it.

STEN Feed Geometry



While both guns use a magazine box to feed the cartridges, the Thompson submachine gun uses a fully staggered magazine. Earlier versions of the Thompson also had a drum magazine option. By the time the M1A1 version was fielded, the drum magazine was discontinued, and the cuts that allowed its use were not present. The STEN's magazine has the rounds staggered in the body of the magazine but funnels those rounds to a single round at the top of the magazine. This helps ensure that only one round is fed into the chamber.

The Thompson's design of the feed ramp, while very good from a feeding standpoint, is much more difficult to machine and, as a consequence, is more costly. In addition, having the chamber so far forward in the receiver makes clearing a "fail to extract" malfunctioning round difficult and makes the gun harder to clean. Feed-system design, though, is one of the most important aspects of any weapons performance. A great deal of testing must be done to ensure good performance. Small variations and subtleties in magazine dimensions can have enormous impact on gun reliability and function. The Thompson design team's approach compensated for different magazine configurations, and this type of design has stood the test of time.

Chapter 8
Technical Drawings

The following drawings represent a "best effort" to reverse engineer a single gun sample of an M1A1. The drawings for the large components are categorized by individual operations to make the part requirements clear. Part-cut sequencing was done for convenience and not according to any engineering or machining requirement.

The material selections and heat treats provided are what one would normally expect to be specified with the steels available today. Generally, most of the intricate small parts for the M1A1 would be manufactured using an investment cast process or using the Metal Injection Molded (MIM) process. Parts such as the trigger, disconnector, trip, sear, magazine latch, and sear lever would be made most cost-effectively using those technologies. The determination of how to make any of these parts would depend on the capital money the firm or individual would be able to spend versus the overall cost of the gun they wanted it to be under. One usually obtains a lower-piece price by spending more capital dollars. A good example is the cost of molding a part using an MIM die. Multiple cavities in a mold cost more, but because you obtain more parts for every opening and closing of the die, the piece price is less. Most of the cylindrical parts would be made today using Swiss Screw machines or Computer Numerical Control Turning Centers (CNC).

The frame and receiver would best be done by machining these components from a solid billet of material. The original gun was made in this fashion. It required multiple stagings of the part to do all the cuts and required gaging and tooling for each operation. Today, one would probably use a CNC machining center with multiple parts fixtured on a "tombstone" with multiple parts on a side and different fixture loadings to obtain access for all the machining cuts required. This would improve cut-to-cut accuracy because the part would be held in one set-up for the machining. While some would argue that these two components could also start out as investment cast blanks with secondary machining, this would not necessarily reduce the piece price. When one considers the die tooling cost, along with development time, straightening tooling, and the fact that you would probably end up machining all the internal surfaces anyway to obtain the necessary tolerancing and size requirements of the part, investment-casting a blank would probably not result in a significant cost improvement.

Thread selections are as specified during the war. Many of these are not normally called out by today's standards. An example of this is many of the screw threads are #14 (.242)-24 threads versus today's more common ¼-20 or ¼-28 standard thread series.

Generally, the springs used in the M1A1 are very well designed. The stress levels are low so that even under dynamic loading, the springs should not take a "set" and lose spring force. Calculations for the springs are provided using precision-grade tolerancing to improve consistency from gun-to-gun function. These calculations can be made by hand, but software is available from the Spring Manufacturers Institute that makes this process extremely easy and understandable.

M1A1 Parts List

- Action Spring
- Bolt Handle
- Breech Bolt Assembly
  - Breech Bolt
  - Extractor
- Buffer Assembly
  - Buffer
  - Buffer Plate (2)
  - Buffer Rivet (2)
- Buffer Pivot
- Fore End Assembly
  - Forend
  - Sling Swivel Base
  - Sling Swivel Loop
  - Sling Swivel Screw (2)
- Fore End Attachment Screw
- Frame Assembly
  - Disconnector
  - Disconnector Spring
  - Frame
  - Pivot Plate Assembly
    - Pivot Plate
    - Pivot Pin Front
    - Pivot Pin Rear
  - Rear Grip
  - Rear Grip Retaining Screw
  - Rocker
  - Rocker Pivot Assembly
    - Indicator Pin
    - Rocker Pivot
  - Safety Lever Assembly
    - Indicator Pin
    - Safety
  - Sear
  - Sear Lever
  - Sear Spring
  - Trigger
  - Trigger Return Spring
  - Trip
- Magazine Box Assembly
  - Magazine Box
  - Magazine Box Bottom
  - Magazine Follower
  - Magazine Retainer
  - Magazine Spring
- Magazine Latch Assembly
  - Magazine Latch
  - Magazine Latch Pivot
- Magazine Latch Spring
- Oiler Assembly
  - Oiler Body
  - Oiler Bottom
  - Oiler Cap
  - Oiler Gasket
  - Oiler Threaded Insert
  - Oiler Stem
- Receiver Assembly
  - Barrel
  - Ejector Assembly
    - Ejector Base
    - Ejector Post
    - Ejector Locating Pin
  - Front Sight
  - Front Sight Retaining Pin
  - Forend Iron
  - Frame Latch
  - Frame Latch Spring
  - Receiver
  - Rear Sight
  - Rear Sight Rivets (4)
  - Stock Assembly
  - Butt Plate Assembly
    - Butt Plate Sub-Assy
      - Butt Plate
      - Butt Plate Weldment
    - Oiler Door
    - Oiler Door Pivot Pin
    - Oiler Door Spring
  - Butt Plate Screw Bottom
  - Butt Plate Screw Top
  - Stock
  - Stock Front Takedown Screw
  - Stock Rear Takedown Screw
  - Stock Takedown Screw Washer (2)
  - Stock Reinforcement Washer Left
  - Stock Reinforcement Washer Right
  - Stock Reinforcement Screw
  - Sling Swivel Screw (2)
  - Sling Swivel Loop
  - Sling Swivel Base

Manufaturing Data:

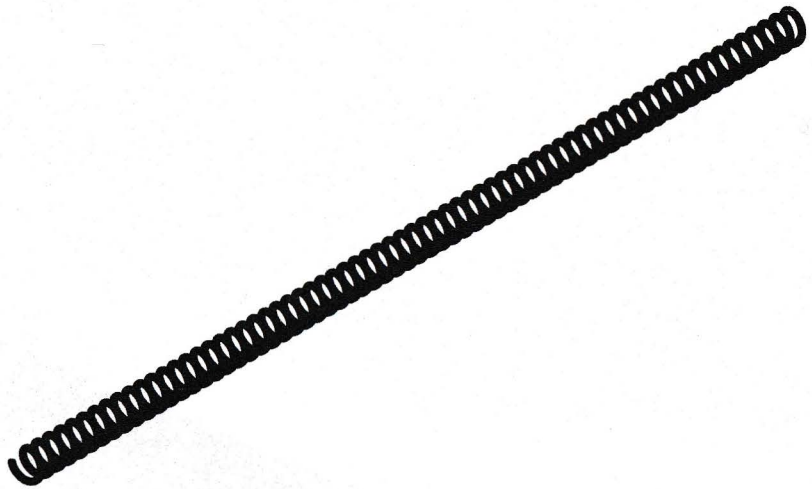
Spring Type:	Helical Compression
Outside Diameter:	.388 inches
Wire Diameter:	.042
Total Coils:	68
Active Coils:	68
Coil Type:	Open, Not Ground
Free Length:	11.313
Wind Direction:	Either Hand

Inspection Data:

Load Length L1:	7.7 inches
Load P1:	5.7 +/-.8 lbs.
Load Length L2:	3.905 inches
Loap P2:	11.75 lbs +/-1.0 lbs.
Max. Solid Height:	2.91 inches
Spring works in a:	.425 diameter hole
Spring works over:	.284 diameter rod

Engineering Data:

Spring Rate:	1.59 lbs/in.
Spring Index:	8.2
Static Solid Stress:	187,250 psi
Stress Percentage: at Solid Height	60%



Dimensions are in Inches

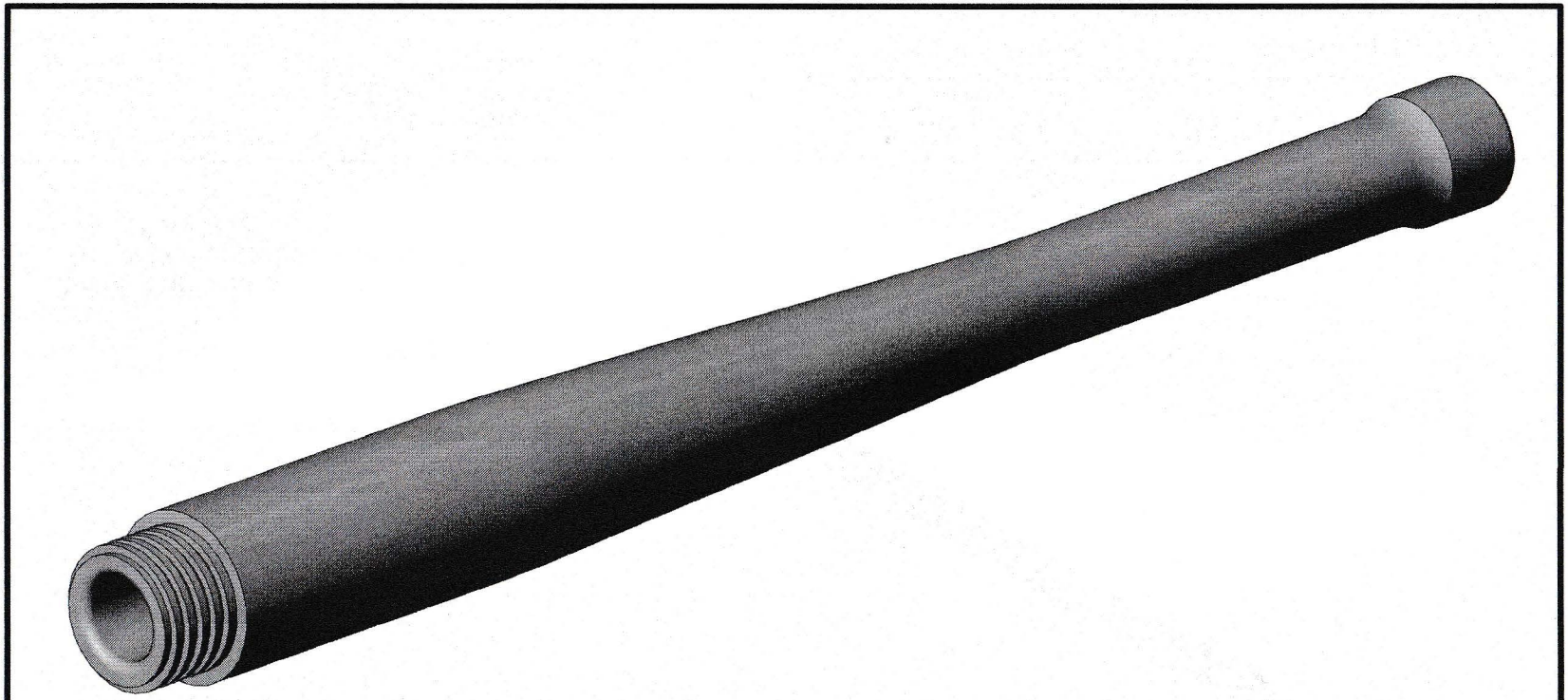
Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL	Music Wire ASTM - A228	M1A1 Thompson	
HEAT TREAT	Stress Relieve	PART NAME	Action Spring
HARDNESS		OPERATION NAME	
FINISH		OPERATION NO.	SCALE 1:2



Dimensions are in Inches

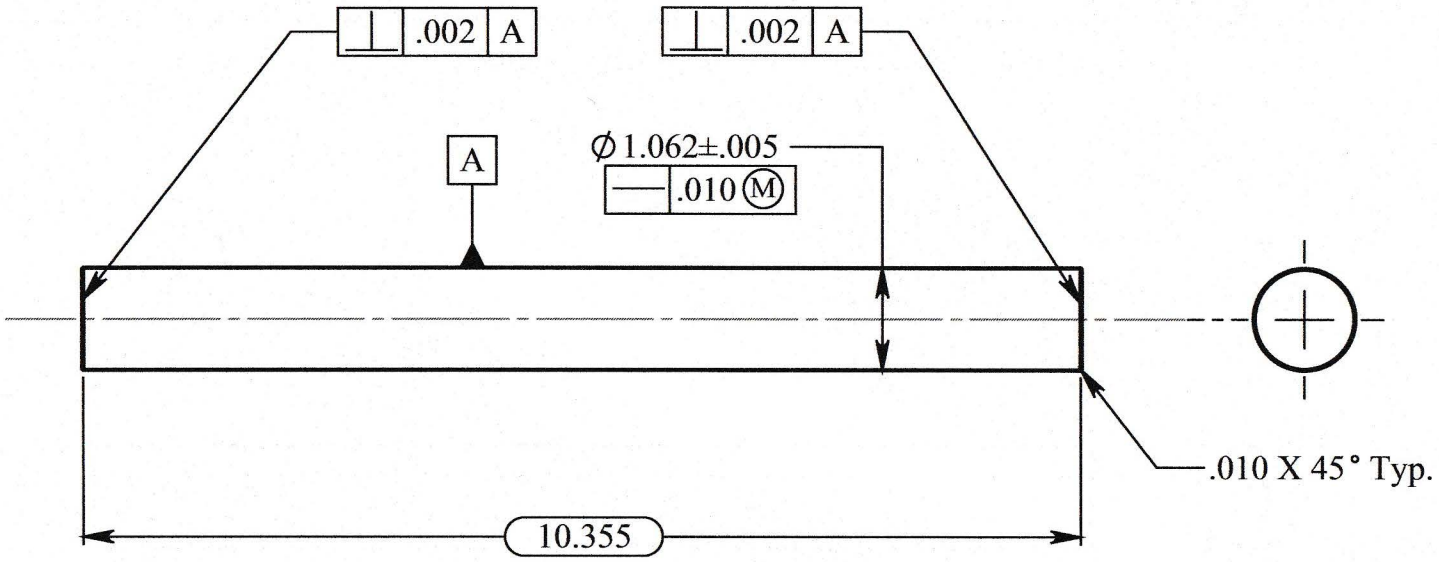
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX

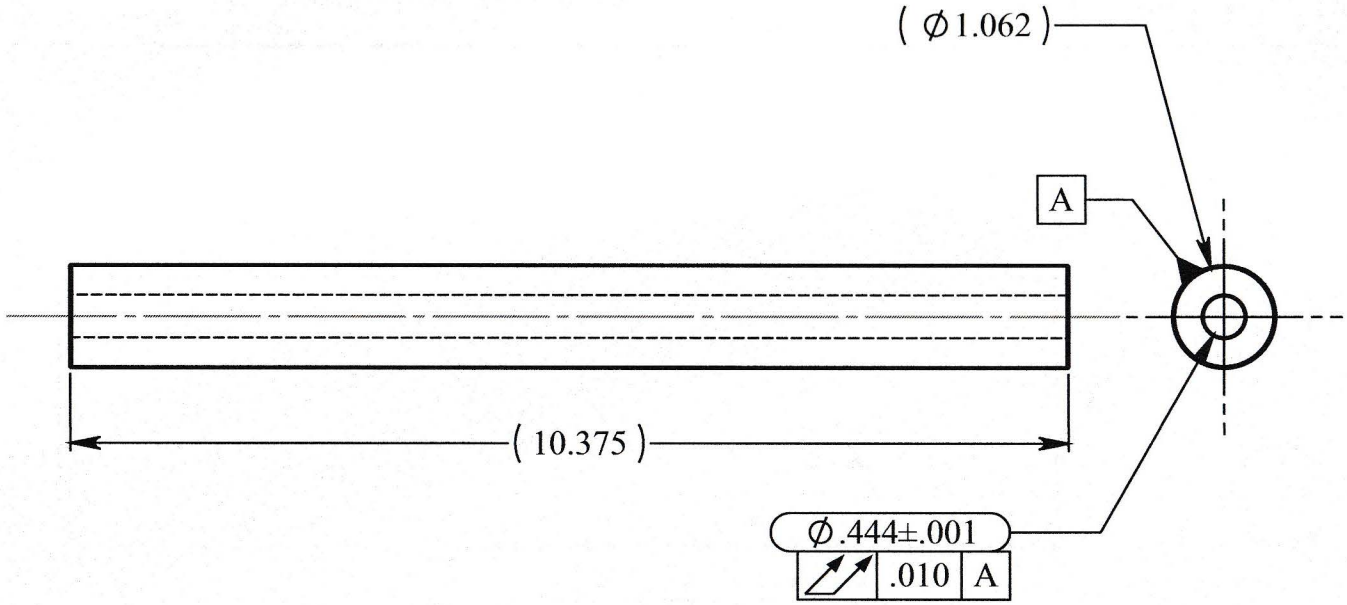
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX

Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME Barrel
HARDNESS	OPERATION NAME
FINISH	OPERATION NO. / SCALE 1X

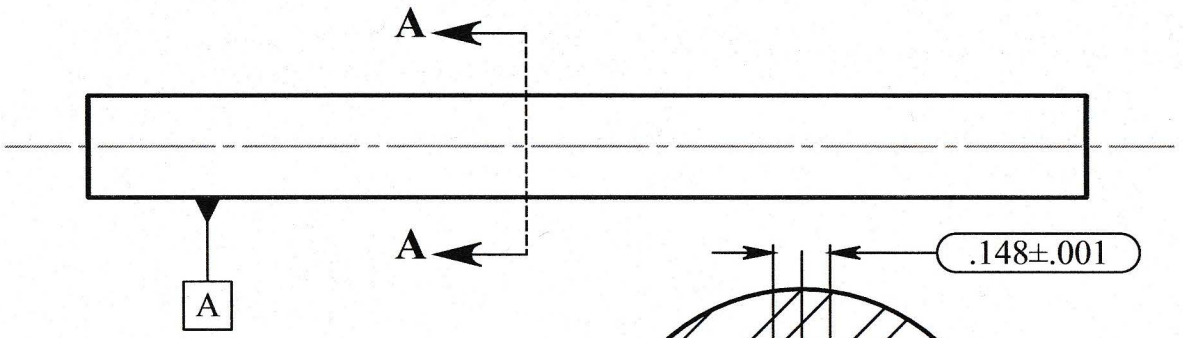


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL: AISI 4140 HEAT TREAT: Quench &Temper HARDNESS: HRC 24-32 FINISH: None	M1A1 Thompson PART NAME: Barrel OPERATION NAME: Cut Off OPERATION NO.: 10 SCALE: 1:2

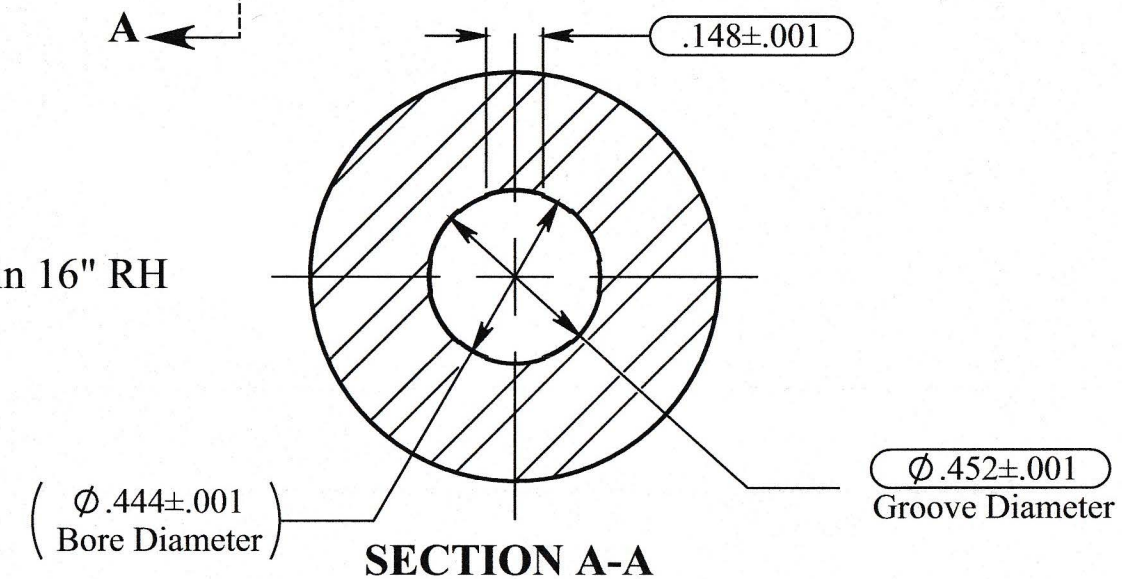


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Barrel
		HARDNESS	OPERATION NAME Gun Drill & Ream
		FINISH	OPERATION NO. 20 / SCALE 1:2

Proprietary and Confidential

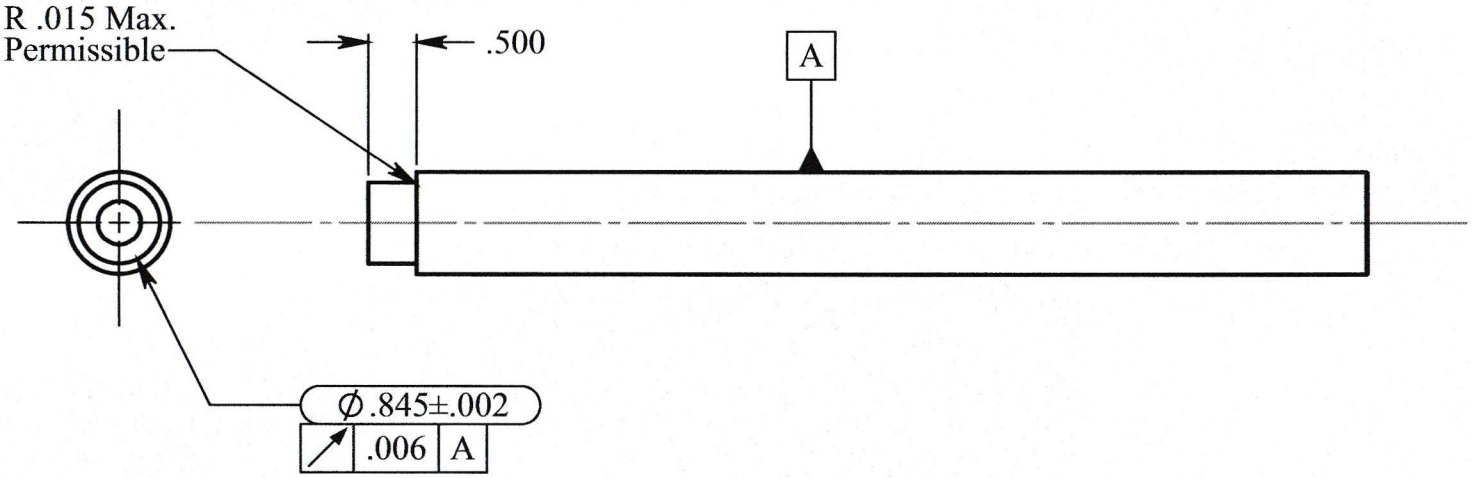


Rifling:
6 Grooves
Twist = 1 Turn in 16" RH

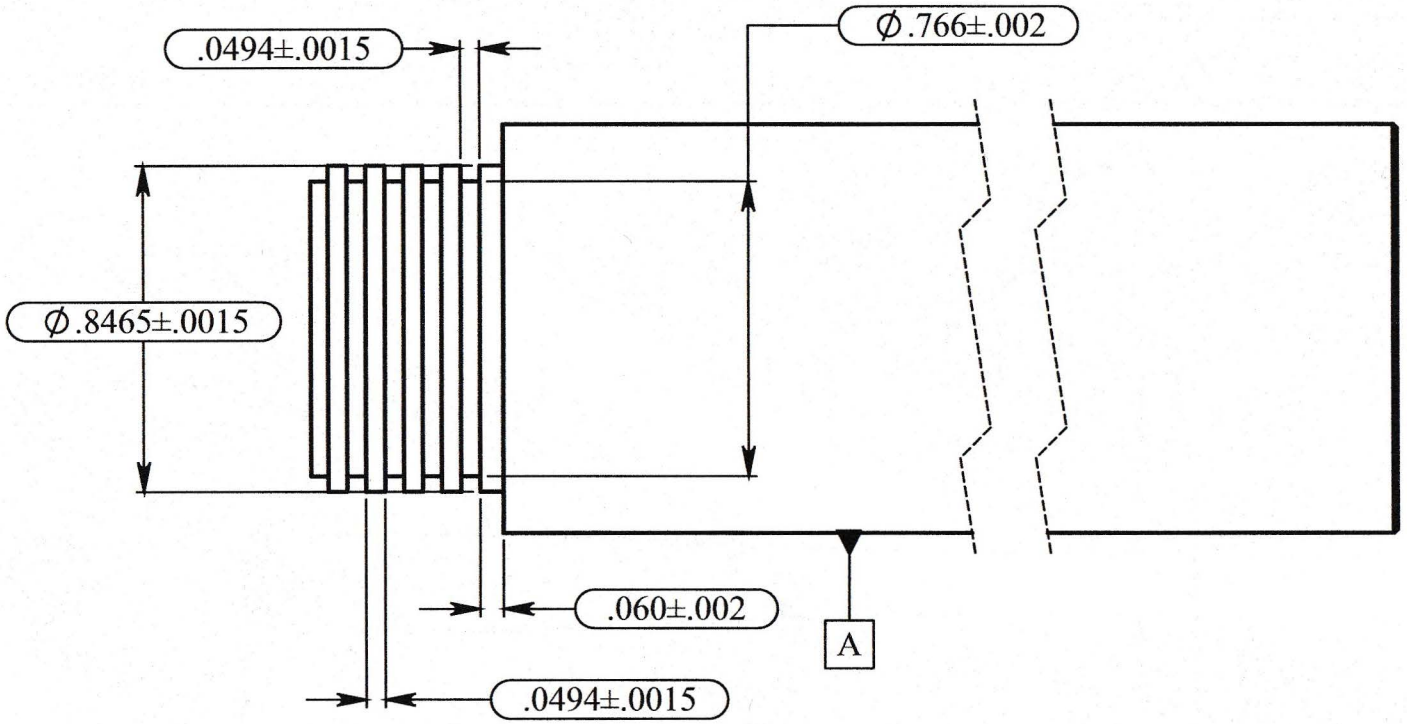


SECTION A-A
SCALE 2 : 1

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Barrel OPERATION NAME: Rifling OPERATION NO.: 30 SCALE: 2x

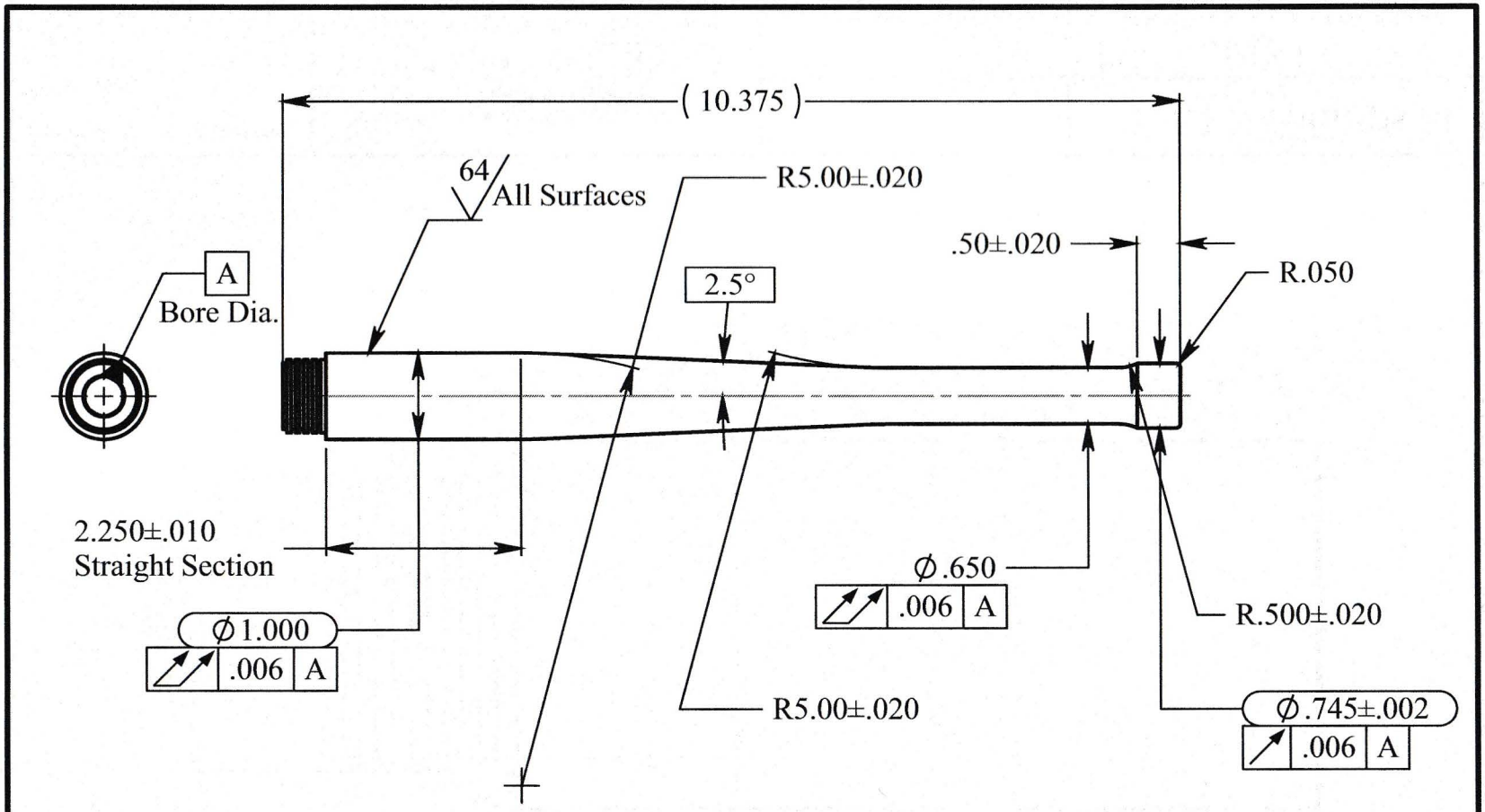


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Barrel
		HARDNESS	OPERATION NAME Hub Operation
	Proprietary and Confidential	FINISH	OPERATION NO. 40 / SCALE 1:2



Square Threads - 10 Threads per Inch RH

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Barrel OPERATION NAME: Hub Threading OPERATION NO.: 50 SCALE: 2:1



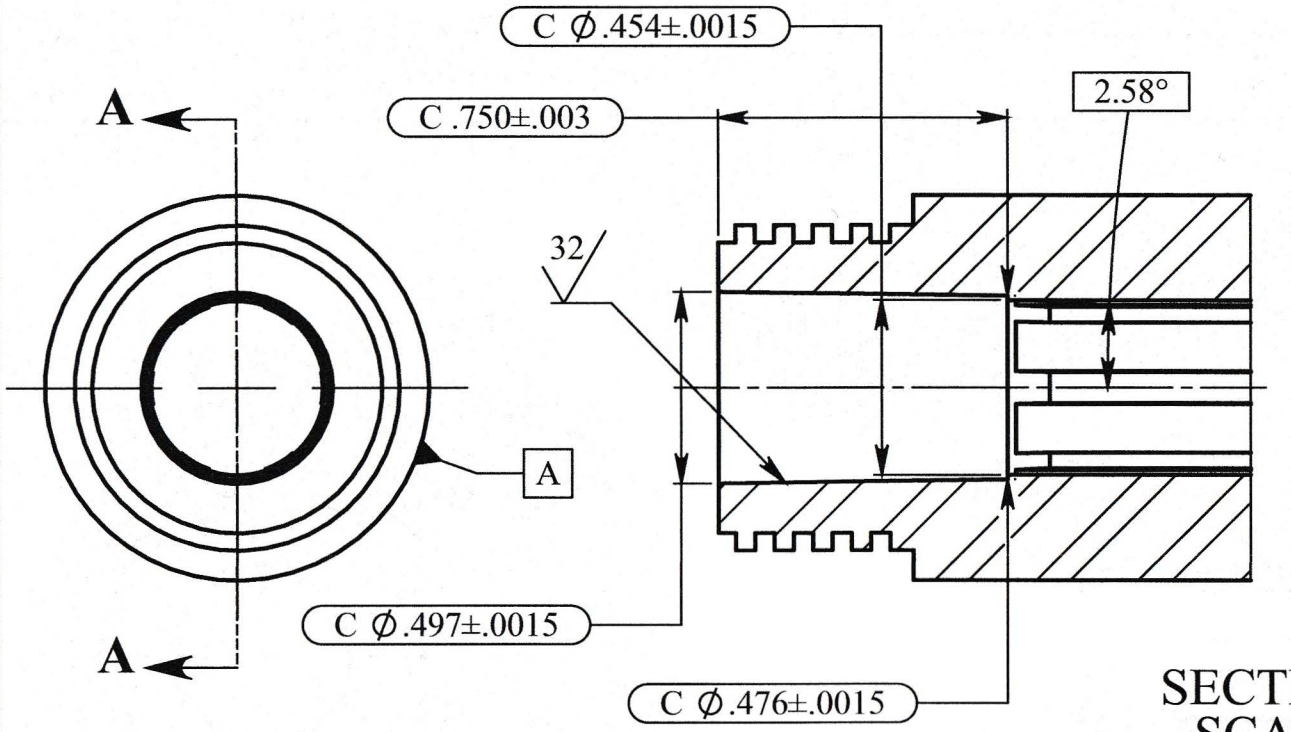
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

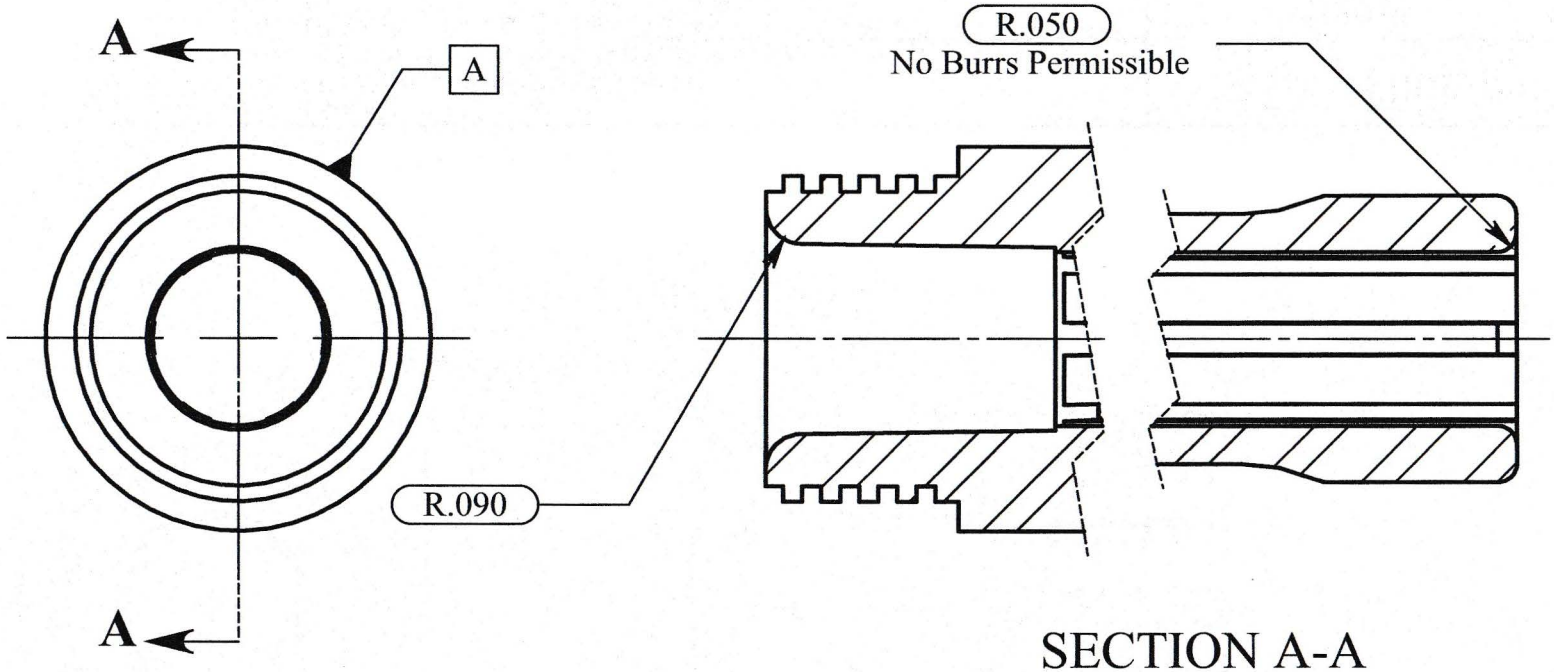
Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Barrel
HARDNESS	OPERATION NAME: Contour
FINISH	OPERATION NO.: 60
	SCALE: 1:2



SECTION A-A
SCALE 2 : 1

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Barrel OPERATION NAME: Chambering OPERATION NO.: 70 SCALE: 2:1



SECTION A-A
SCALE 2 : 1

Dimensions are in Inches

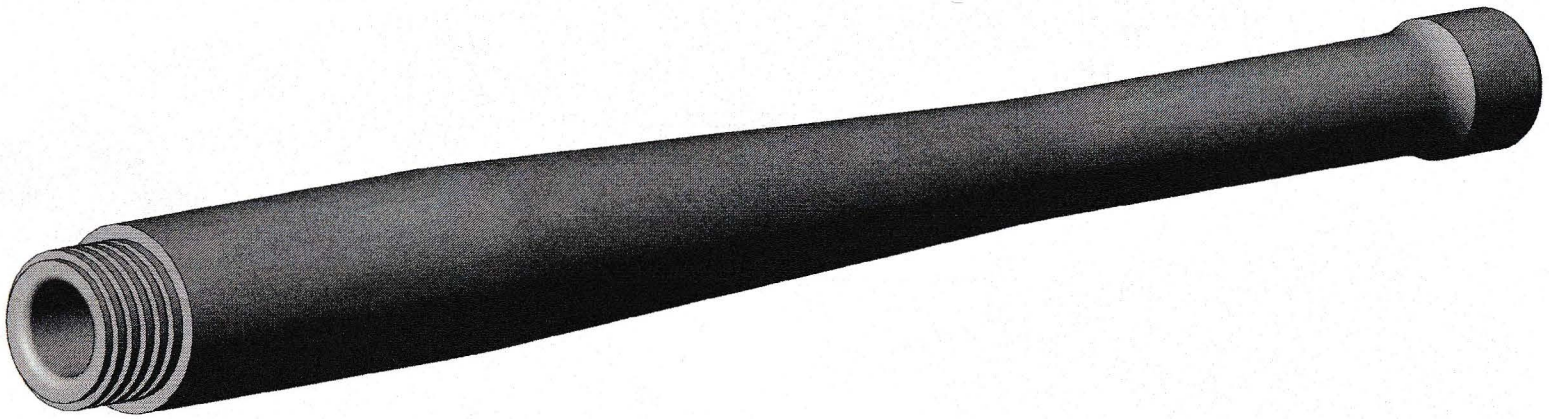
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX

2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

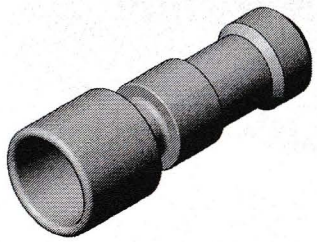
Proprietary and Confidential

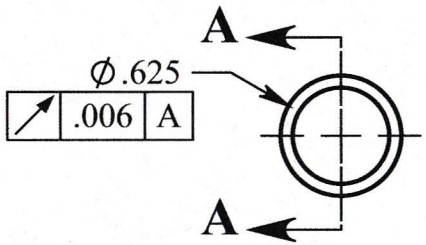
MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME Barrel
HARDNESS	OPERATION NAME Finishing Radii
FINISH	OPERATION NO. 80
	SCALE 1:2

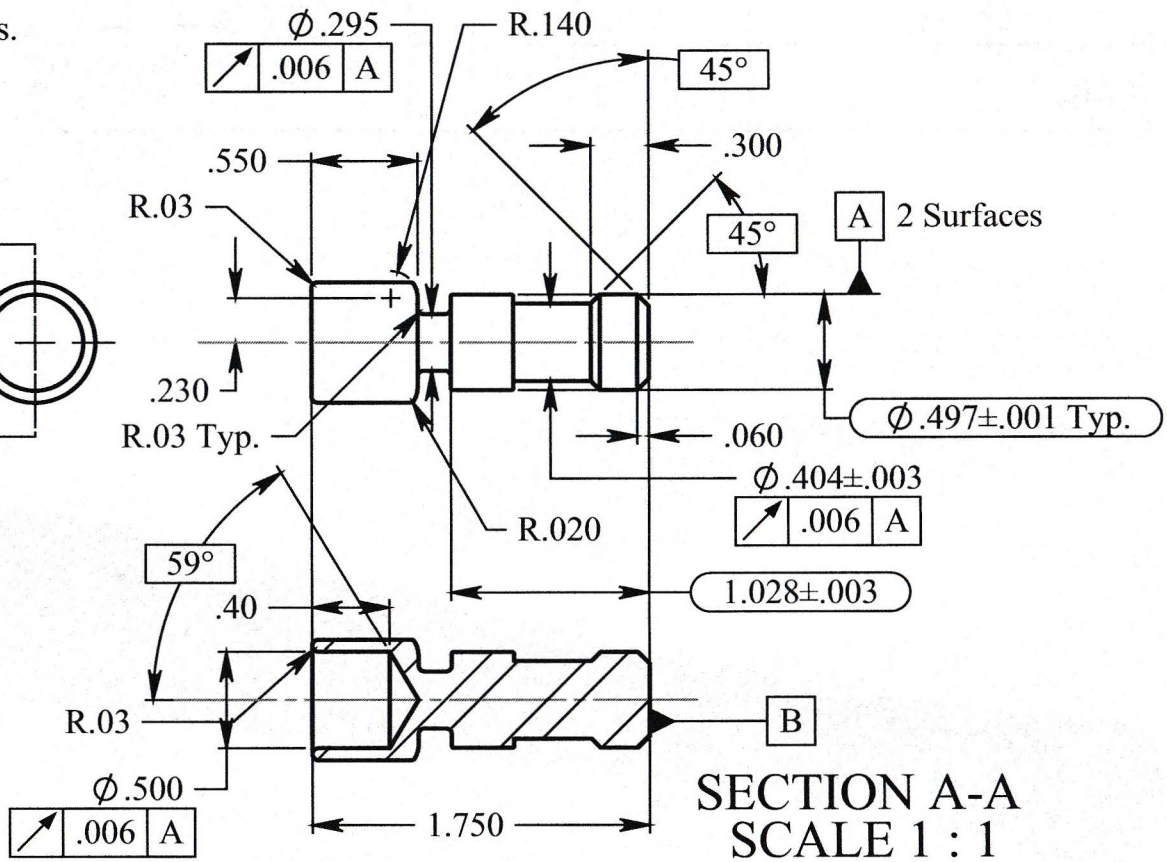


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH: Maganese Phos.	M1A1 Thompson PART NAME: Barrel OPERATION NAME: Finishing OPERATION NO.: 90 SCALE: 1:1

Note: Part Weight = .074 lbs.







SECTION A-A
SCALE 1 : 1

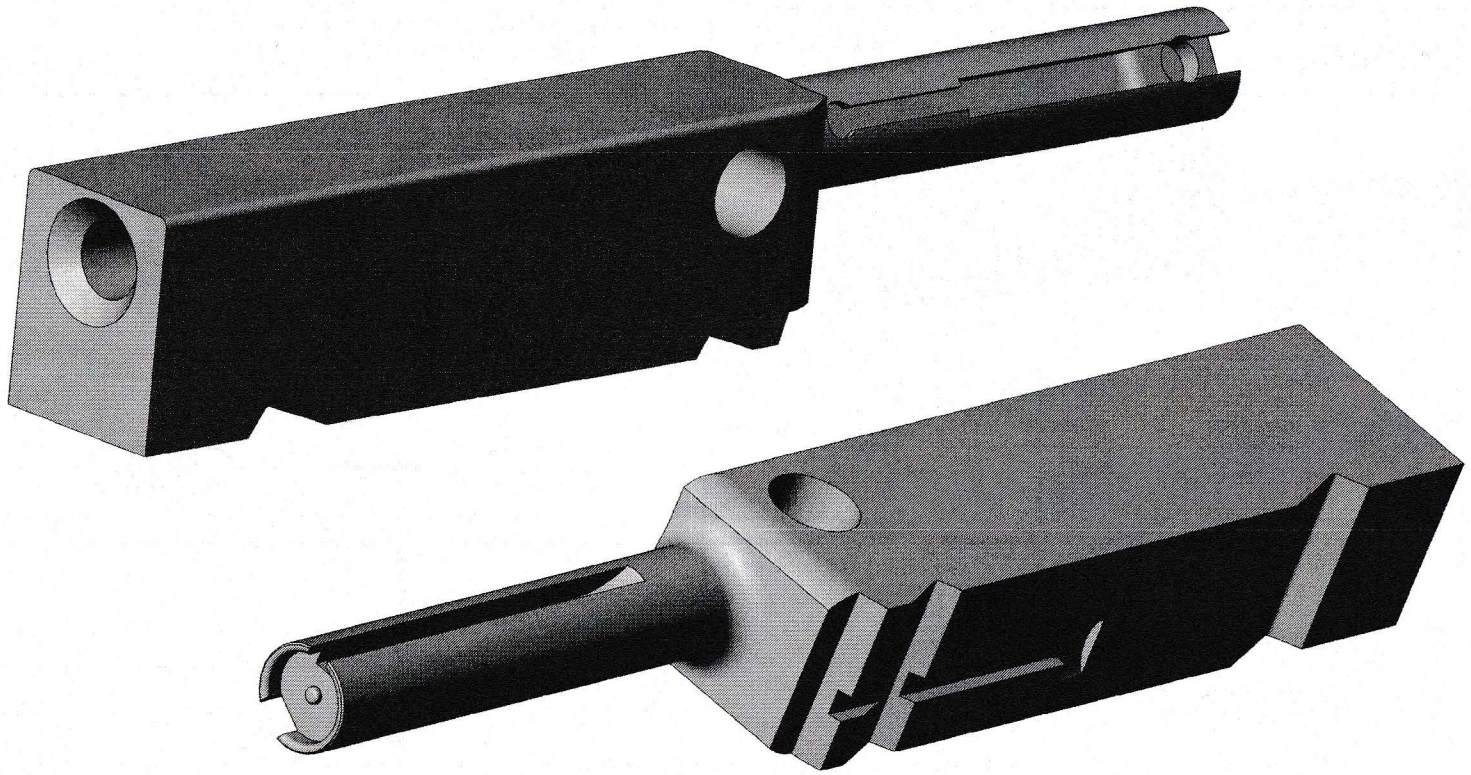
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

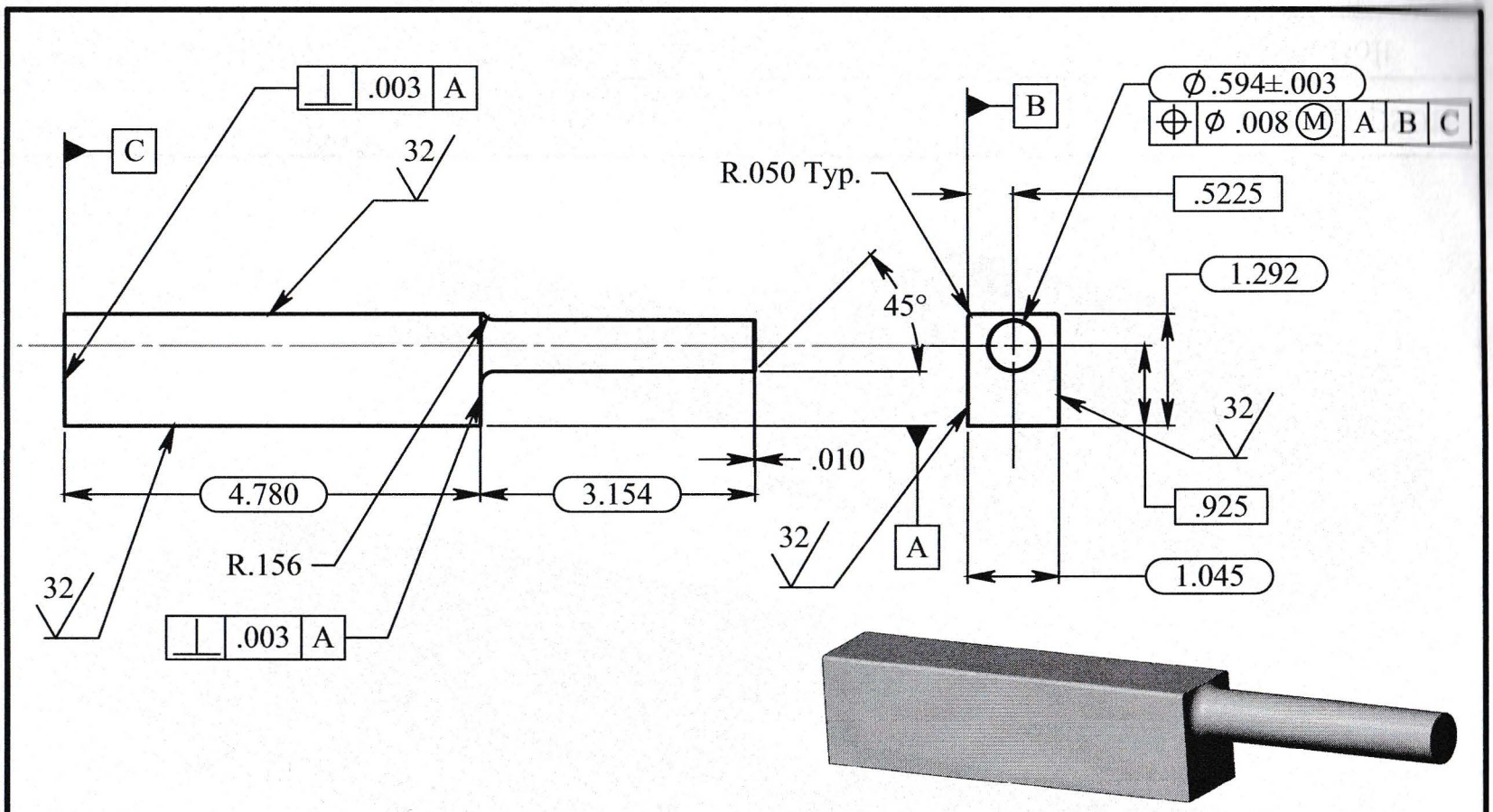
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 4140	M1A1 Thompson
HEAT TREAT: Harden &Temper	PART NAME: Bolt Handle
HARDNESS: HRC 40-45	OPERATION NAME:
FINISH: Maganese Phos.	OPERATION NO.: / SCALE: 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Breech Bolt
		HARDNESS	OPERATION NAME
		FINISH	OPERATION NO. / SCALE 1:1
	Proprietary and Confidential		



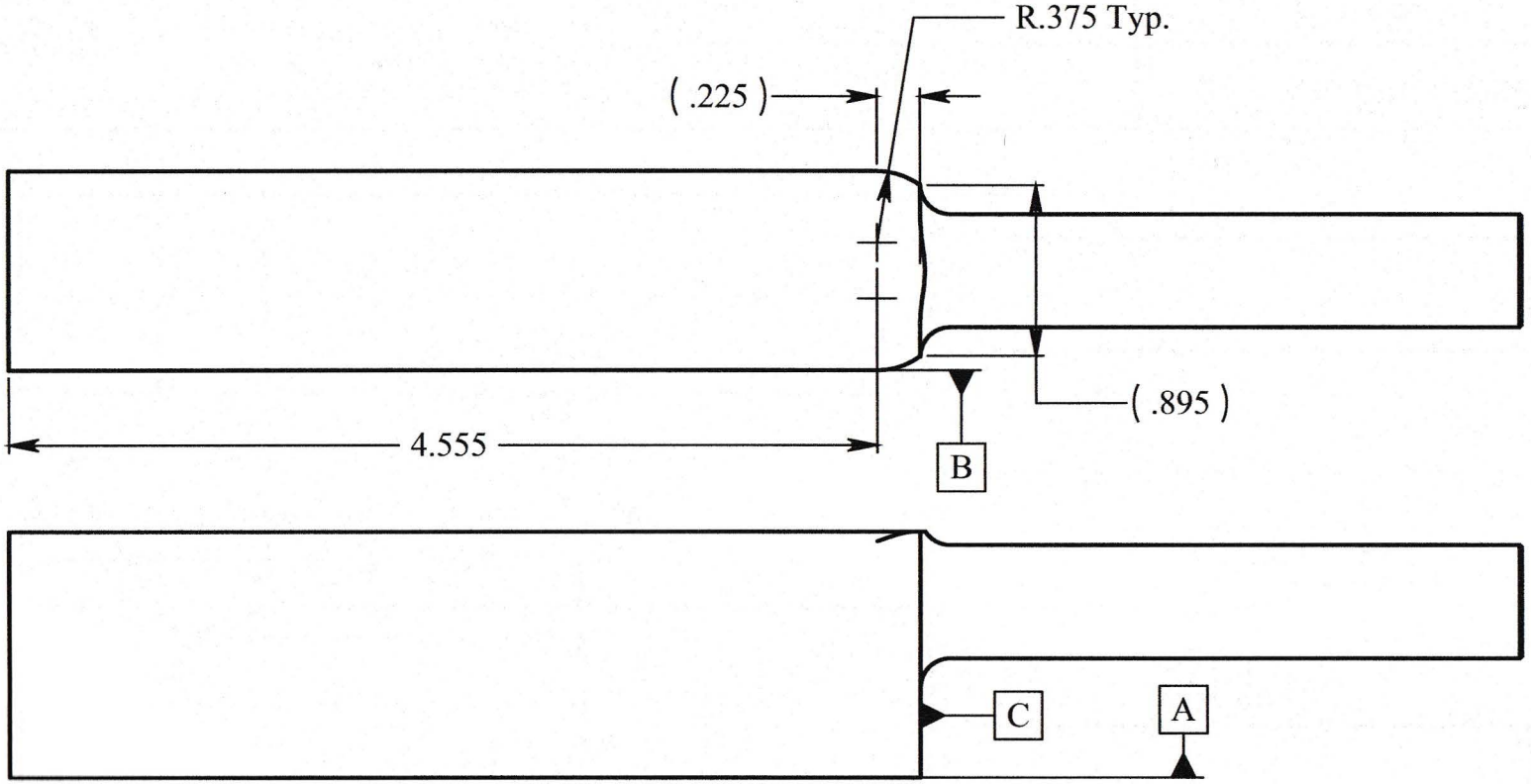
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

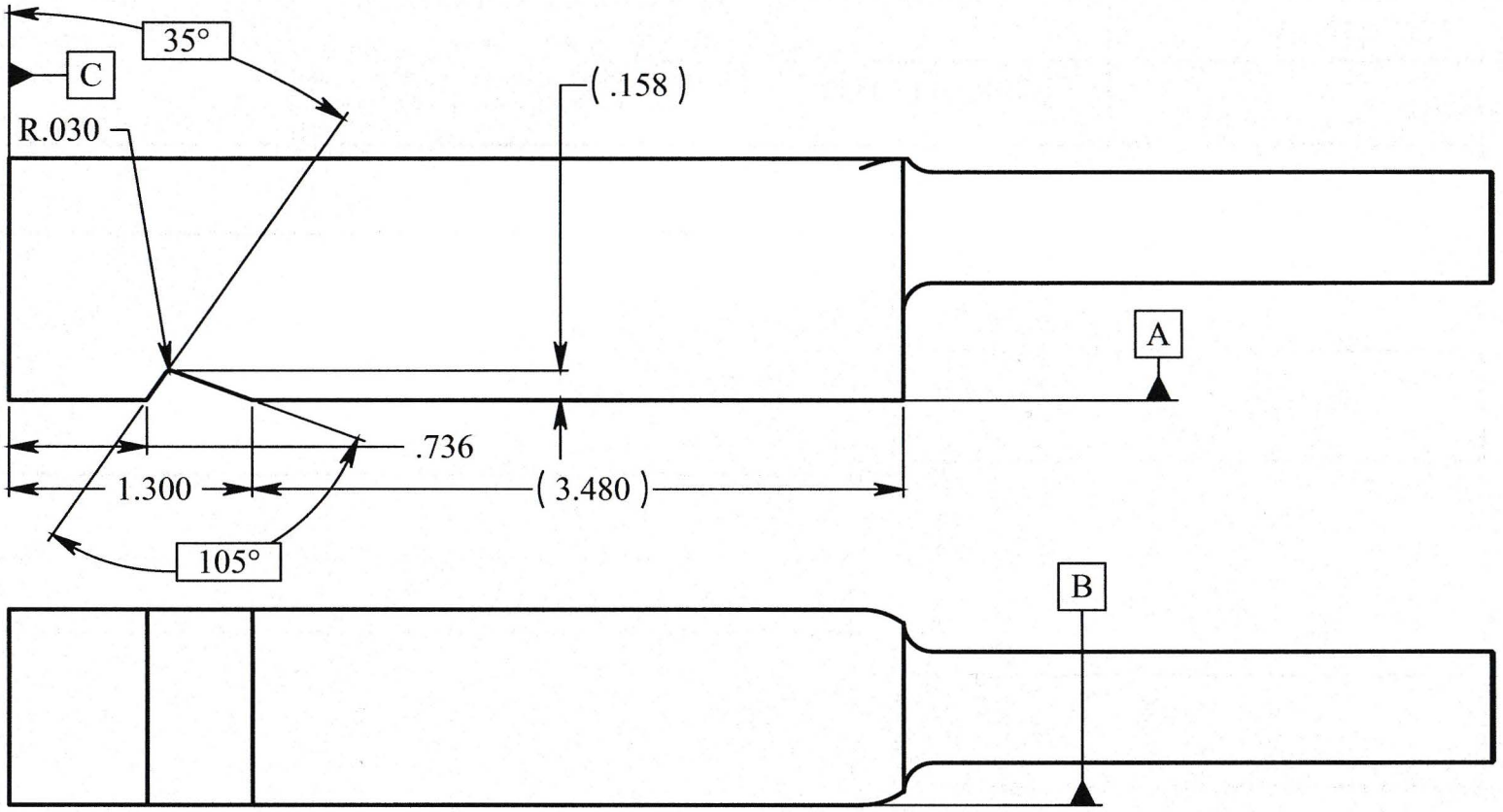
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1118	M1A1 Thompson
HEAT TREAT	PART NAME: Breech Bolt
HARDNESS	OPERATION NAME: Blank
FINISH	OPERATION NO.: 10
	SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)	MATERIAL AISI 1118 Ref.	M1A1 Thompson
		HEAT TREAT	PART NAME Breech Bolt
		HARDNESS	OPERATION NAME Front Bolt Radii
		FINISH	OPERATION NO. 15 — SCALE 1:1
	Proprietary and Confidential		



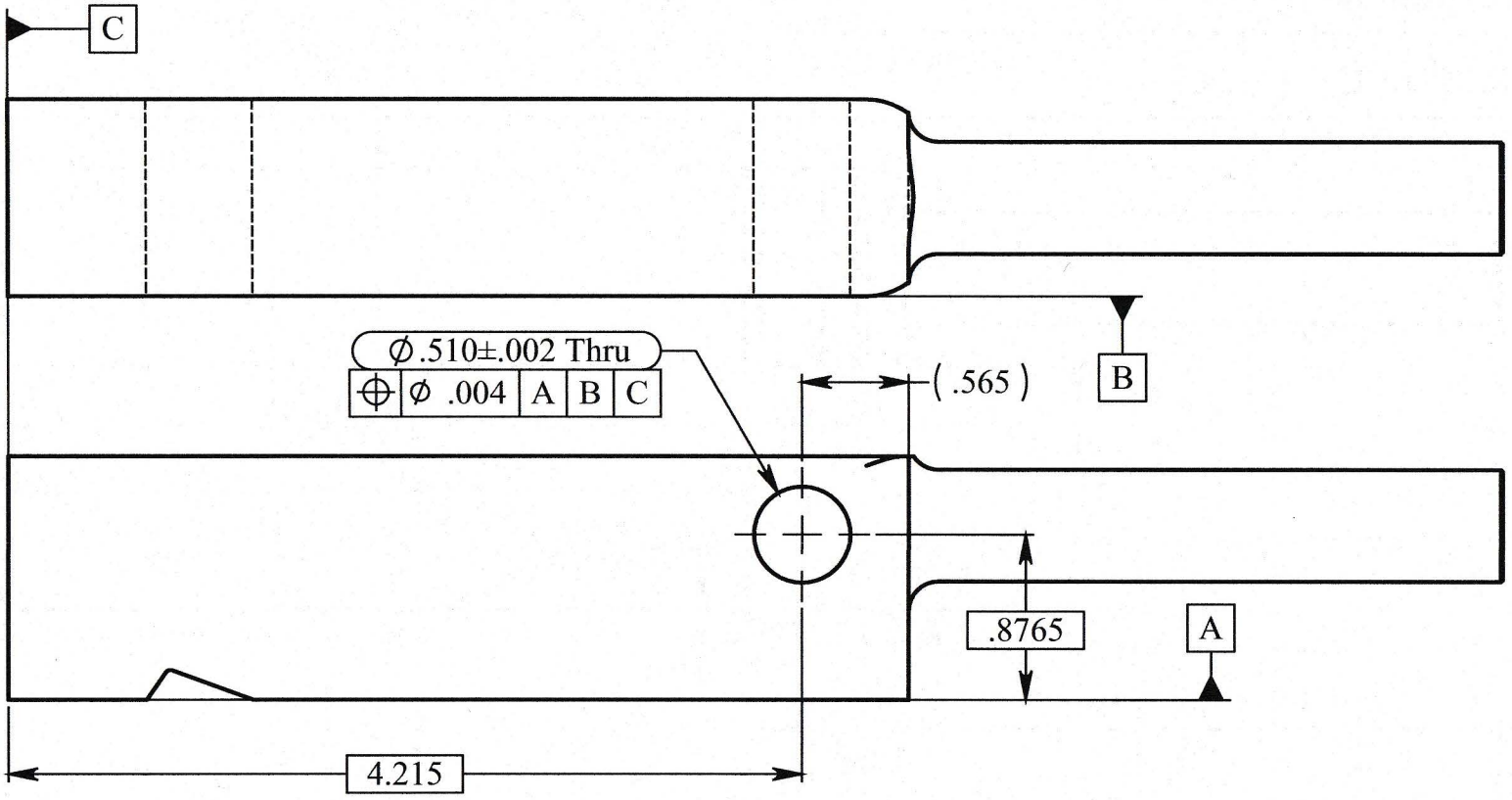
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

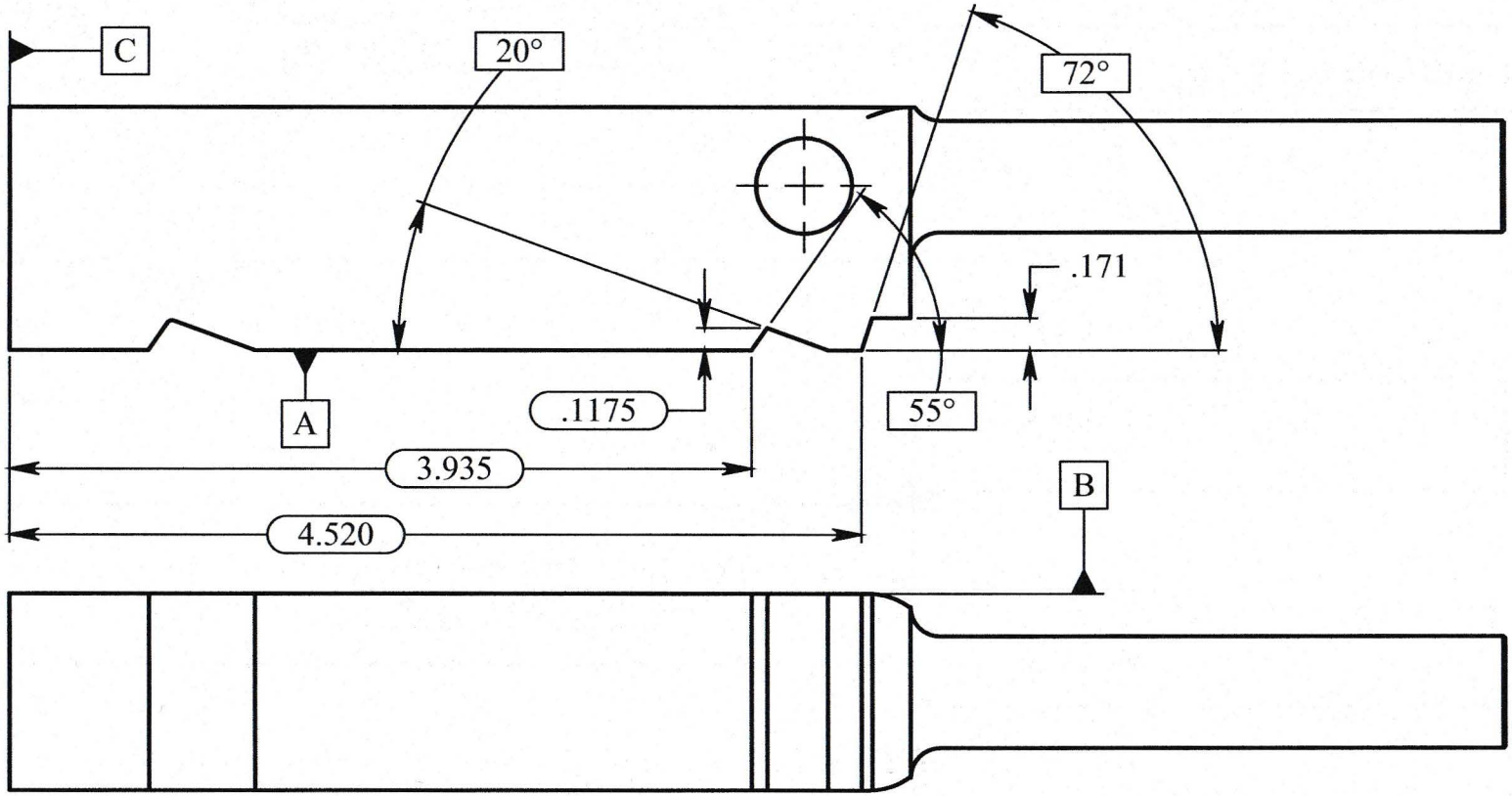
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1118 Ref.	M1A1 Thompson
HEAT TREAT	PART NAME: Breech Bolt
HARDNESS	OPERATION NAME: Rear Sear Notch
FINISH	OPERATION NO.: 20 — SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 1118 Ref.	M1A1 Thompson	
		HEAT TREAT	PART NAME Breech Bolt	
		HARDNESS	OPERATION NAME Bolt Handle Hole	
		FINISH	OPERATION NO. 30	SCALE 1:1
	Proprietary and Confidential			



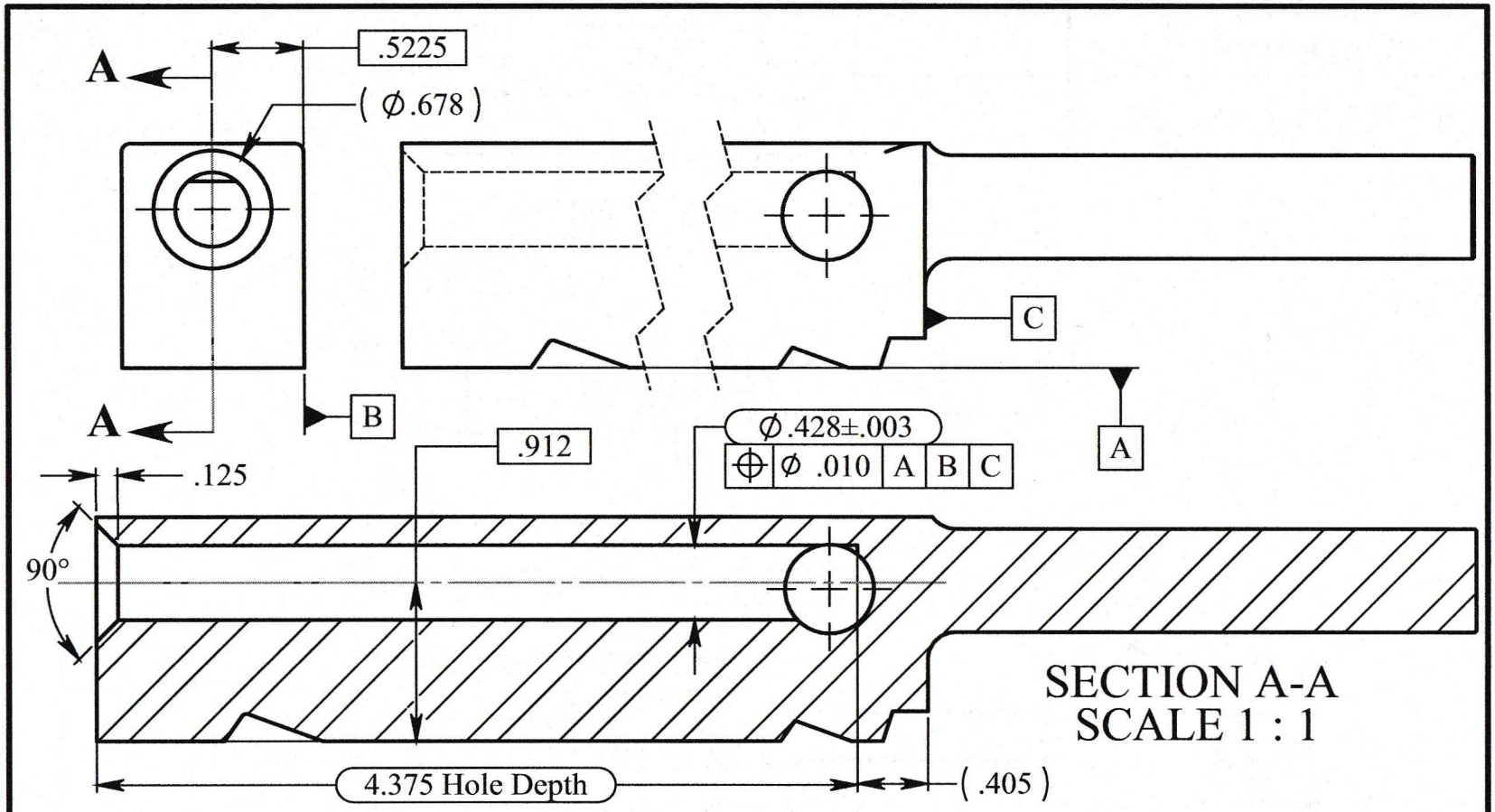
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

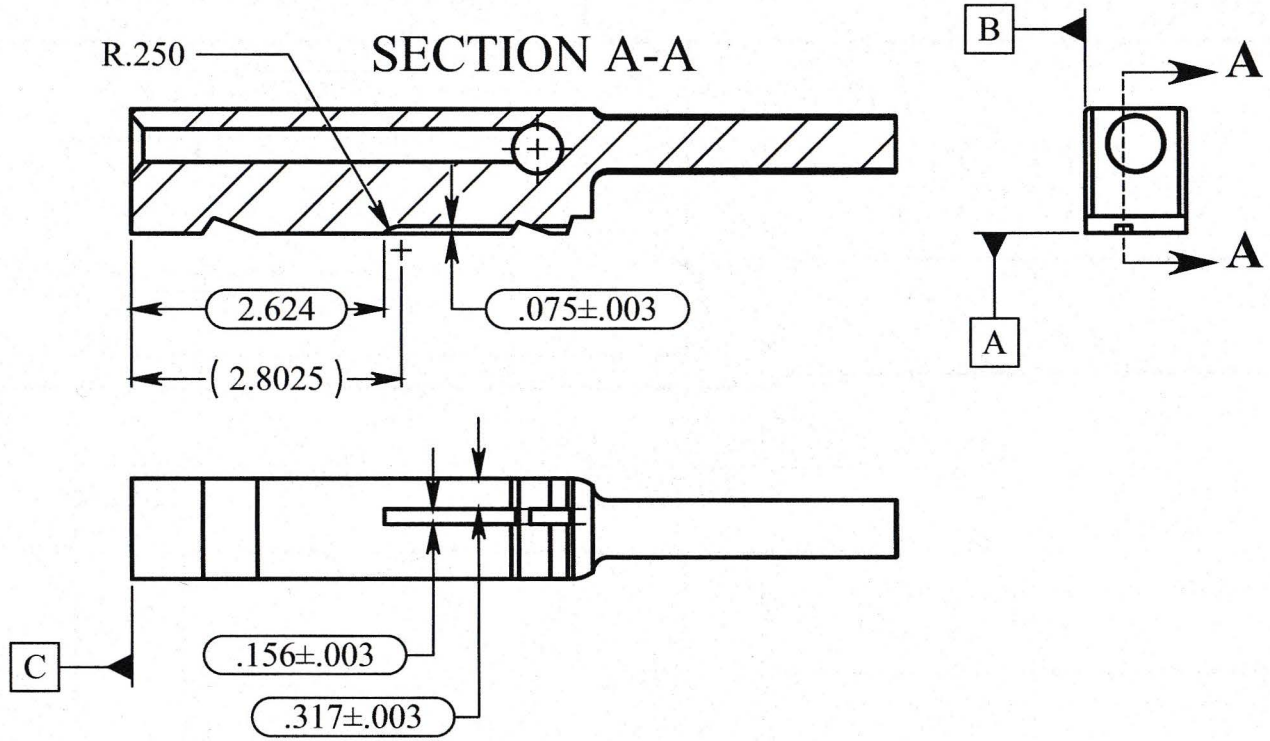
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

MATERIAL: AISI 1118 Ref.	M1A1 Thompson
HEAT TREAT	PART NAME: Breech Bolt
HARDNESS	OPERATION NAME: Front Sear Notch
FINISH	OPERATION NO.: 40
	SCALE: 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL AISI 1118 Ref.	M1A1 Thompson
		HEAT TREAT	PART NAME Breech Bolt
		HARDNESS	OPERATION NAME Recoil Spring Hole
		FINISH	OPERATION NO. 50 / SCALE 1:1
	Proprietary and Confidential		



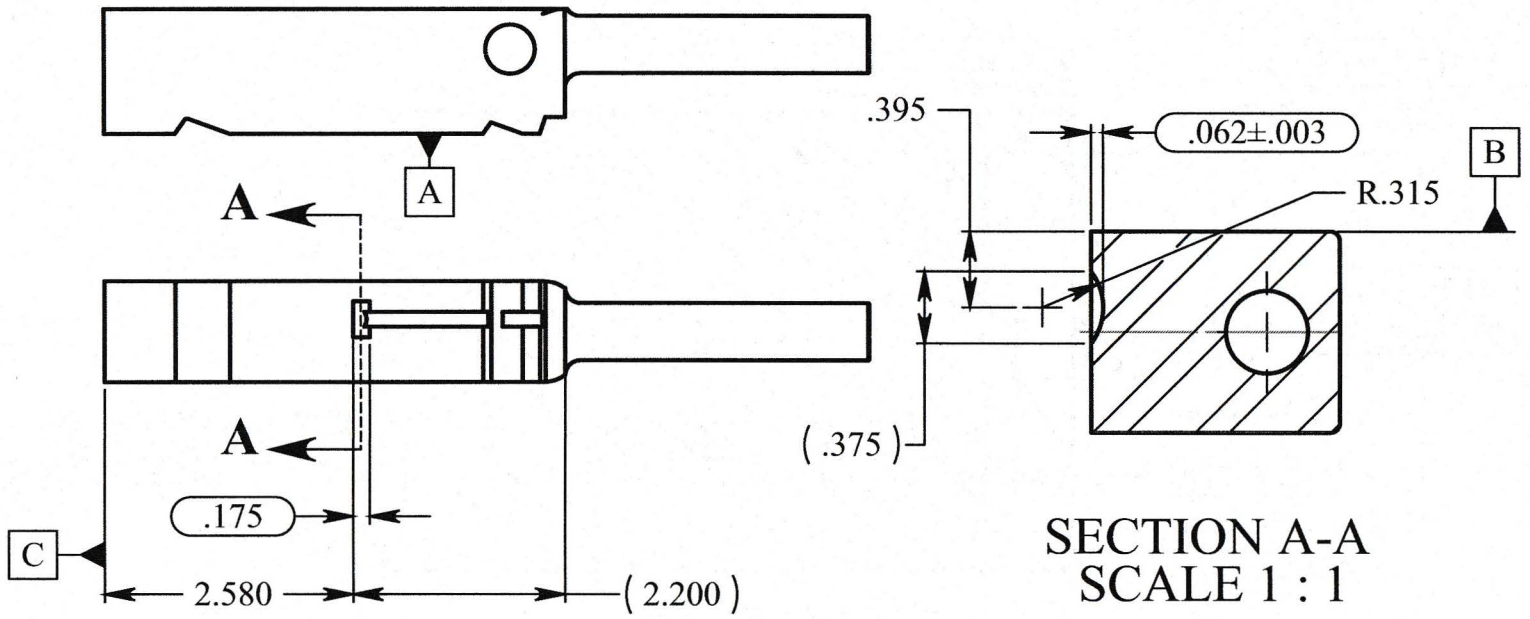
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

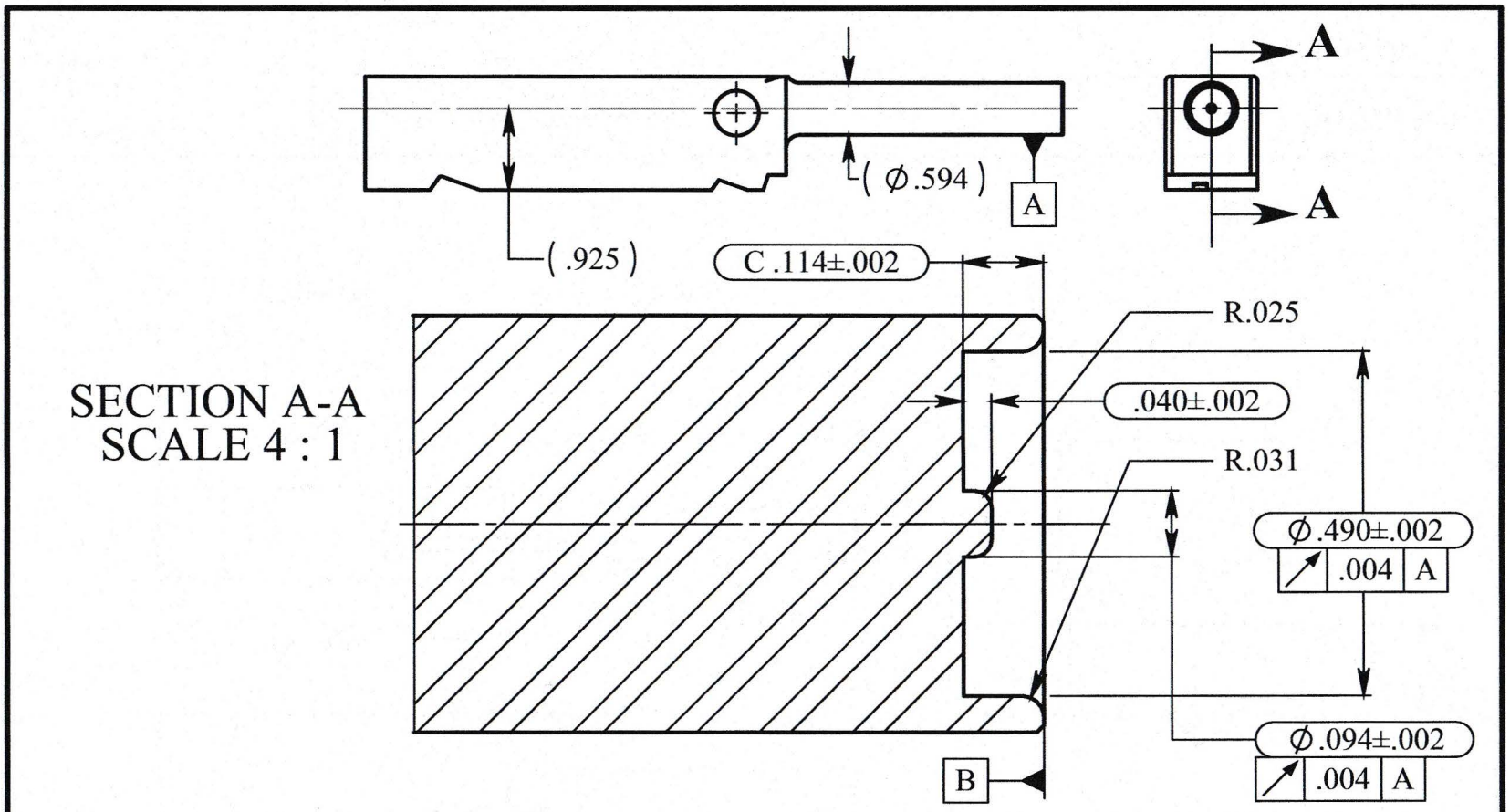
Proprietary and Confidential

MATERIAL: AISI 1118 Ref.	M1A1 Thompson
HEAT TREAT	PART NAME: Breech Bolt
HARDNESS	OPERATION NAME: Bottom Slot
FINISH	OPERATION NO.: 60
	SCALE: 1:2



SECTION A-A
SCALE 1 : 1

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX	MATERIAL AISI 1118 Ref.	M1A1 Thompson
		HEAT TREAT	PART NAME Breech Bolt
		HARDNESS	OPERATION NAME Thumbnail Cut
		FINISH	OPERATION NO. 70 / SCALE 1:2
	Proprietary and Confidential		



SECTION A-A
SCALE 4 : 1

Dimensions are in Inches

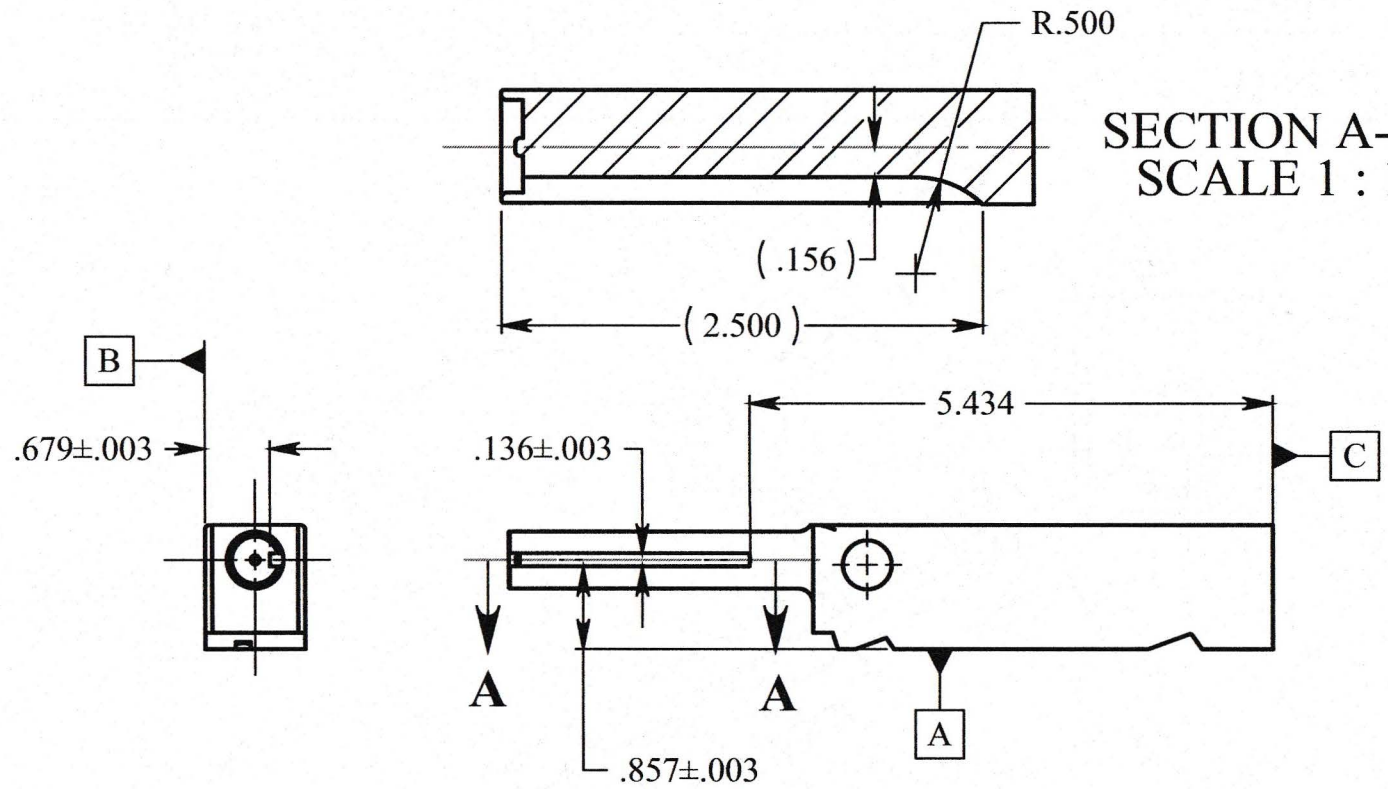
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

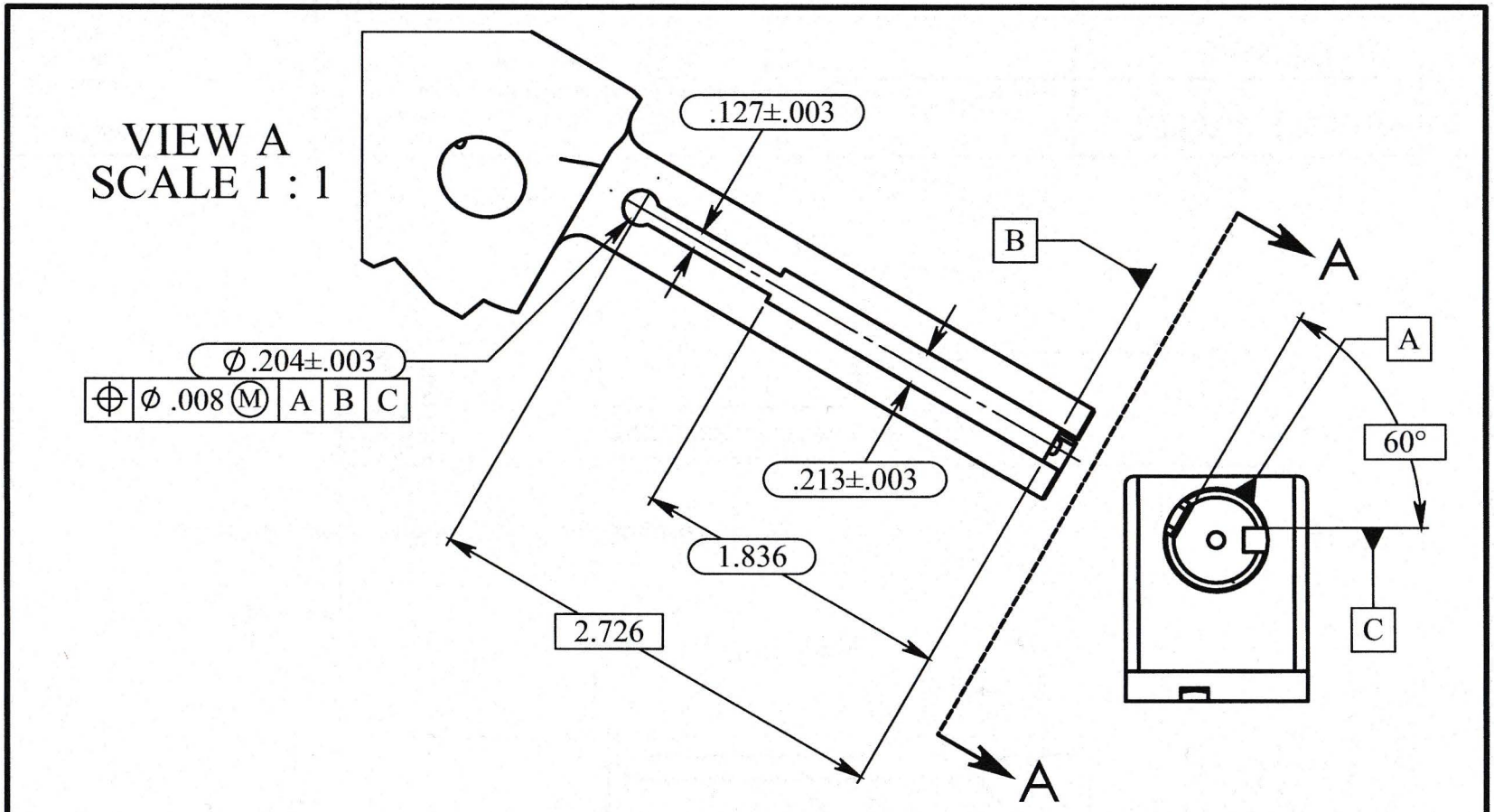
Proprietary and Confidential

MATERIAL: AISI 1118 Ref.	M1A1 Thompson
HEAT TREAT	PART NAME: Breech Bolt
HARDNESS	OPERATION NAME: Bolt Face
FINISH	OPERATION NO.: 80
	SCALE: 1:2

100



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)	MATERIAL AISI 1118 Ref.	M1A1 Thompson
		HEAT TREAT	PART NAME Breech Bolt
		HARDNESS	OPERATION NAME Ejector Clearance
		FINISH	OPERATION NO. 90 / SCALE 1:2
	Proprietary and Confidential		



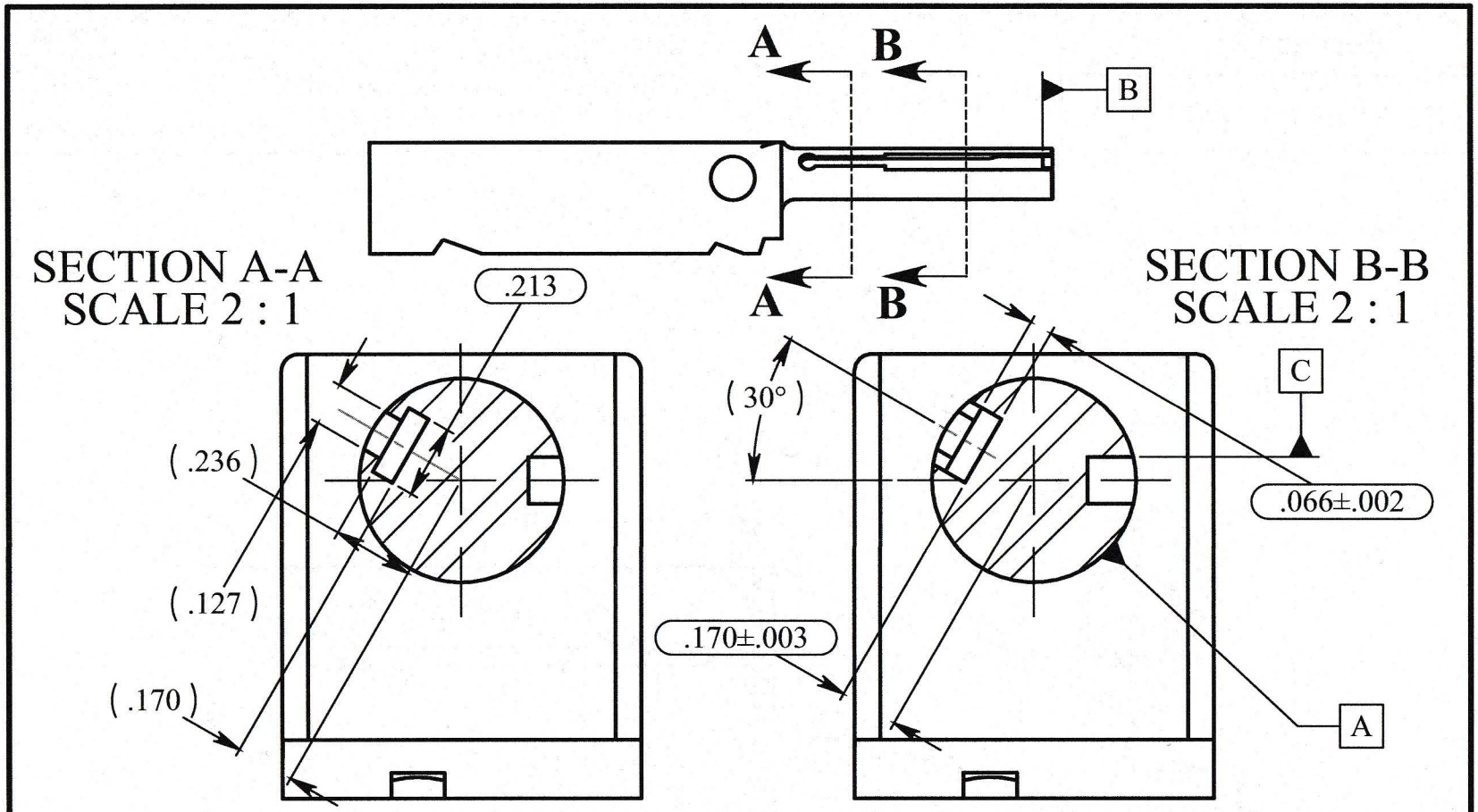
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

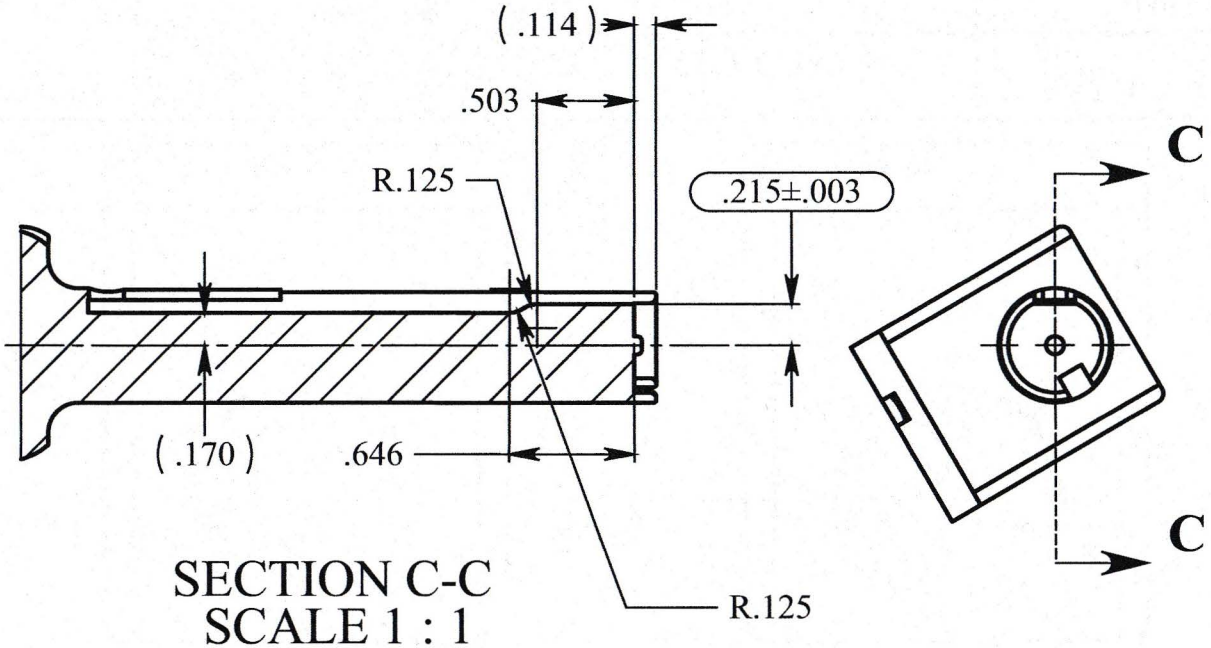
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1118 Ref.	M1A1 Thompson
HEAT TREAT	PART NAME: Breech Bolt
HARDNESS	OPERATION NAME: Extractor Cut
FINISH	OPERATION NO.: 100 — SCALE: 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL: AISI 1118 Ref. HEAT TREAT: HARDNESS: FINISH:	M1A1 Thompson PART NAME: Breech Bolt OPERATION NAME: Extractor Cut OPERATION NO.: 100 SCALE: 2:1



SECTION C-C
SCALE 1 : 1

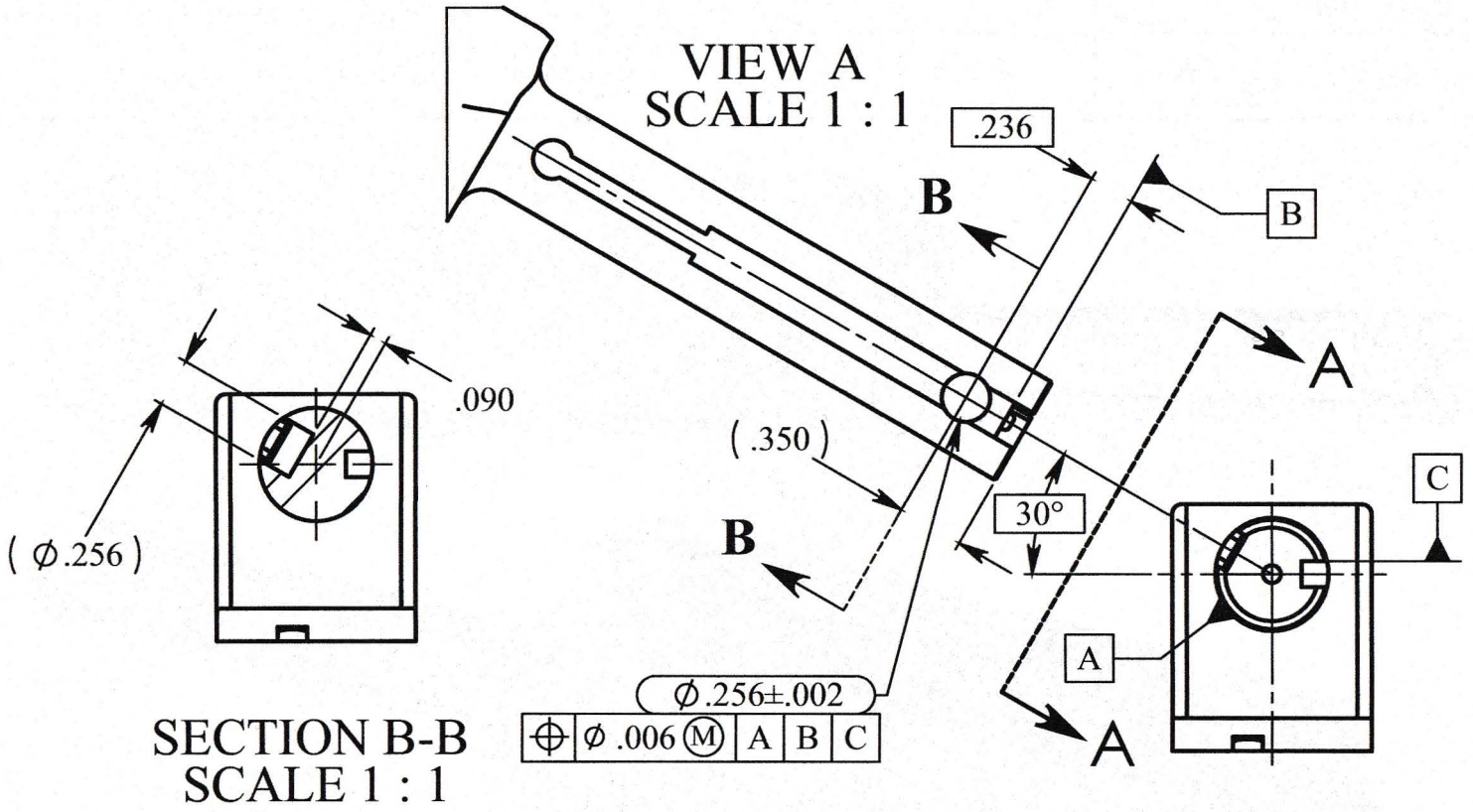
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

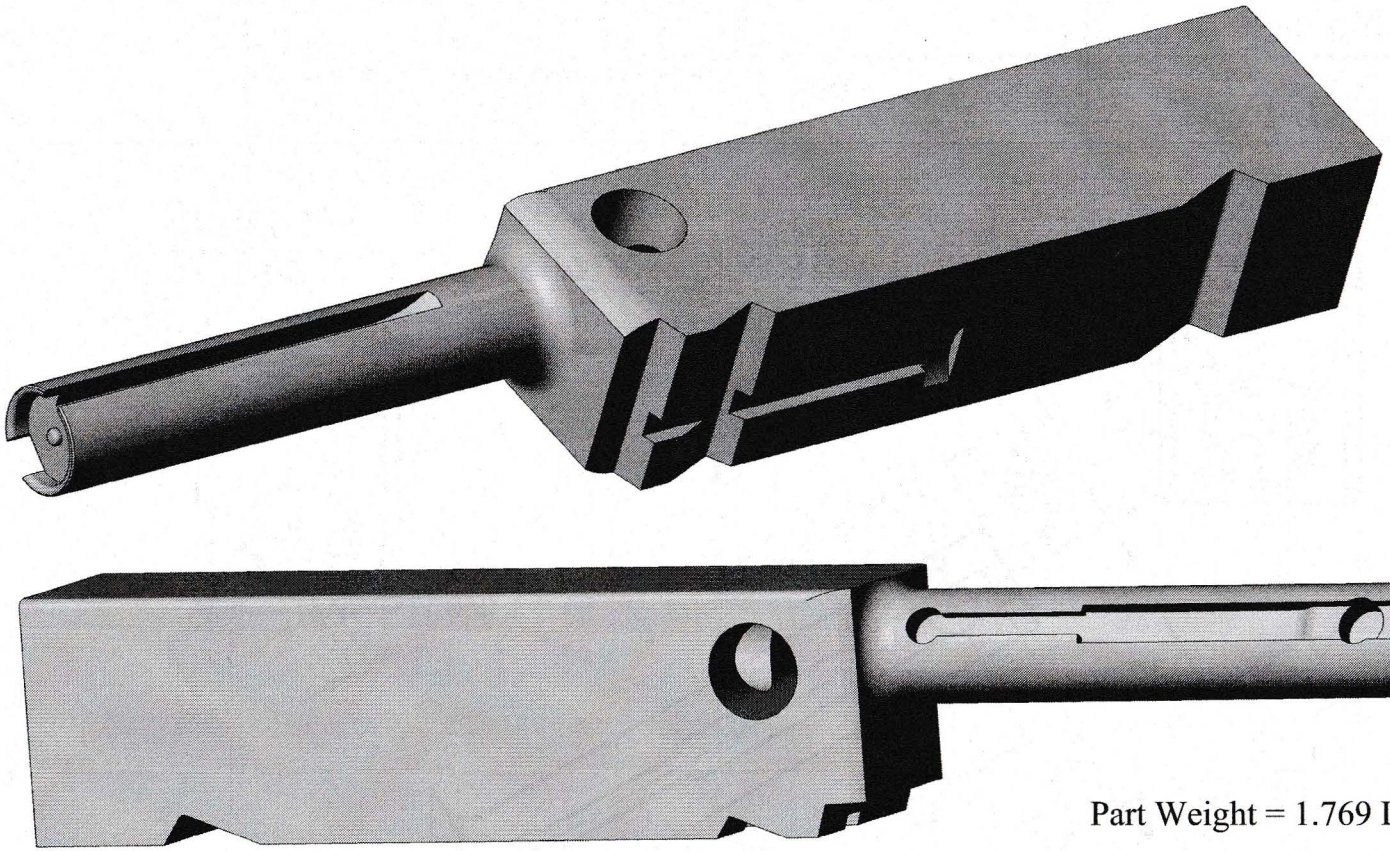
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

MATERIAL: AISI 1118 Ref.	M1A1 Thompson
HEAT TREAT	PART NAME: Breech Bolt
HARDNESS	OPERATION NAME: Extractor Cut
FINISH	OPERATION NO.: 100 — SCALE: 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL AISI 1118 Ref.	M1A1 Thompson	
		HEAT TREAT	PART NAME Breech Bolt	
		HARDNESS	OPERATION NAME Ext. Retention Hole	
		FINISH	OPERATION NO. 110	SCALE 1:1
	Proprietary and Confidential			



Part Weight = 1.769 Lbs. Ref.

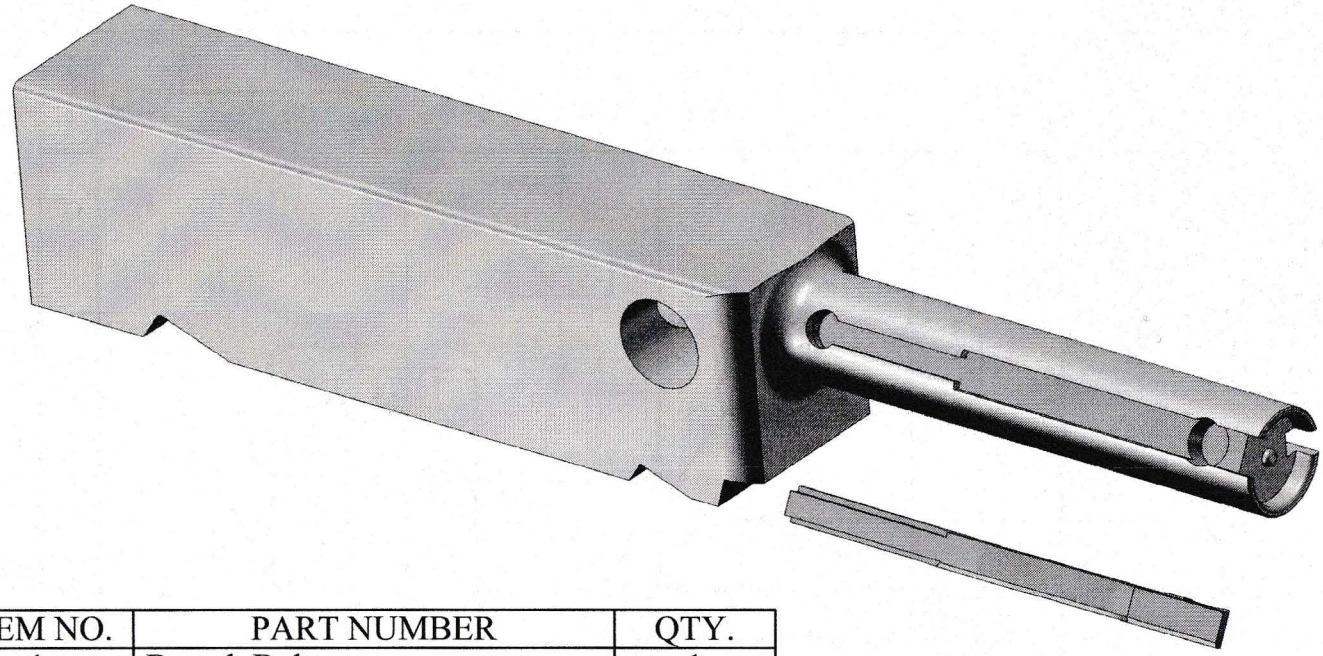
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1118 Ref.	M1A1 Thompson
HEAT TREAT: Carburize .010 Min. Case	PART NAME: Breech Bolt
HARDNESS: HR15N 78 - 85	OPERATION NAME: Finishing
FINISH: Maganese Phos.	OPERATION NO.: 120 — SCALE: 1:1



ITEM NO.	PART NUMBER	QTY.
1	Breech Bolt	1
2	Extractor	1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX

2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH

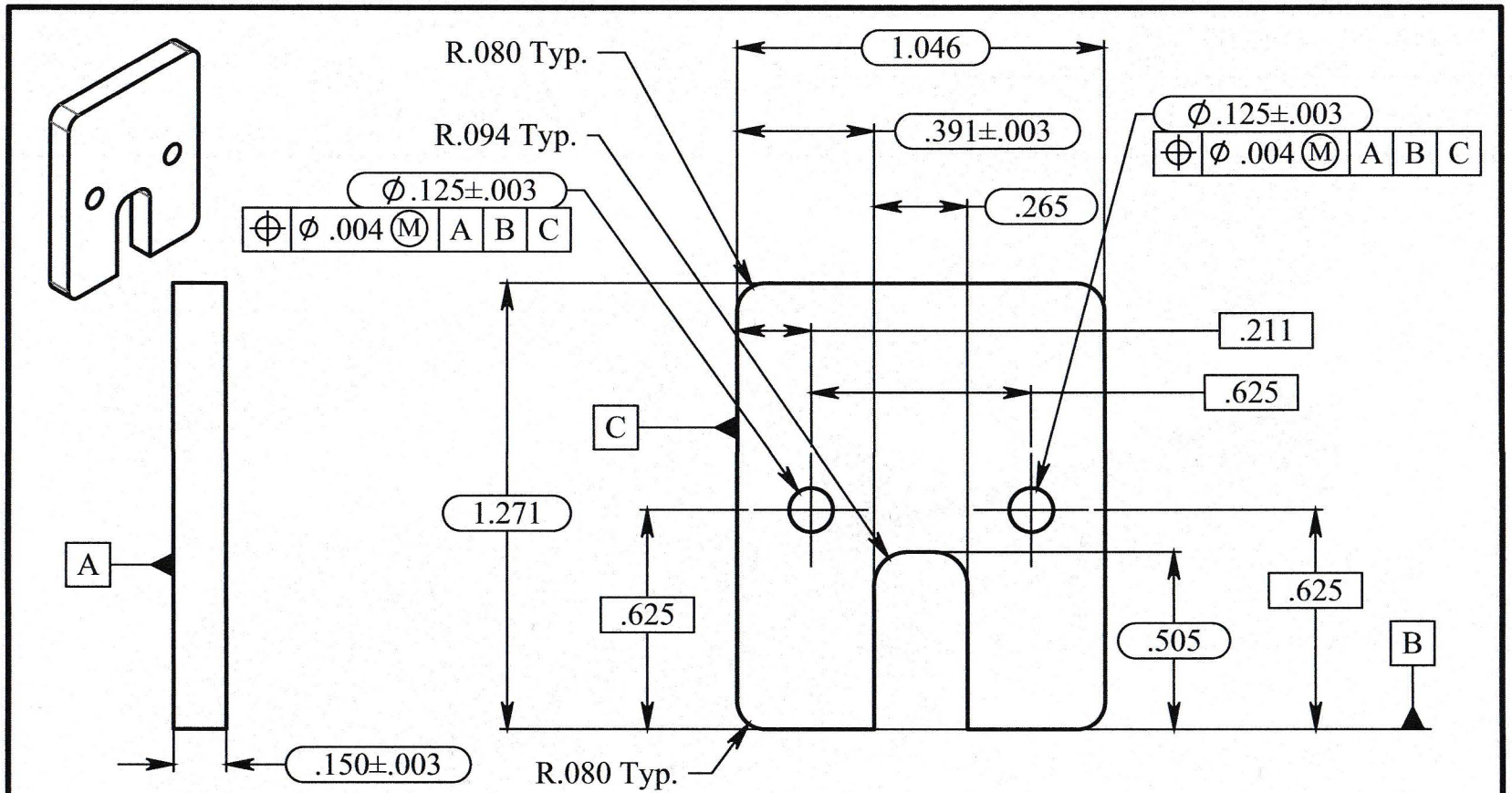
M1A1 Thompson

PART NAME
Breech Bolt Assembly

OPERATION NAME

OPERATION NO.

SCALE
1:1



Dimensions are in Inches

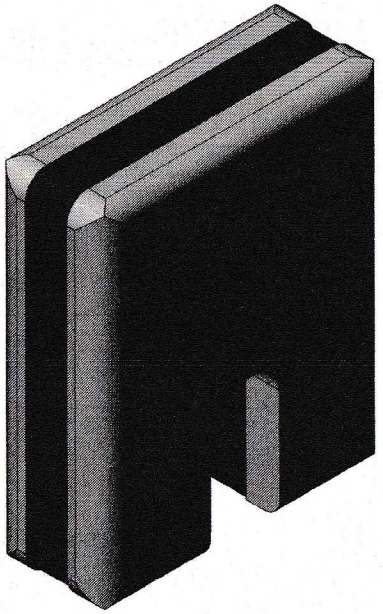
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

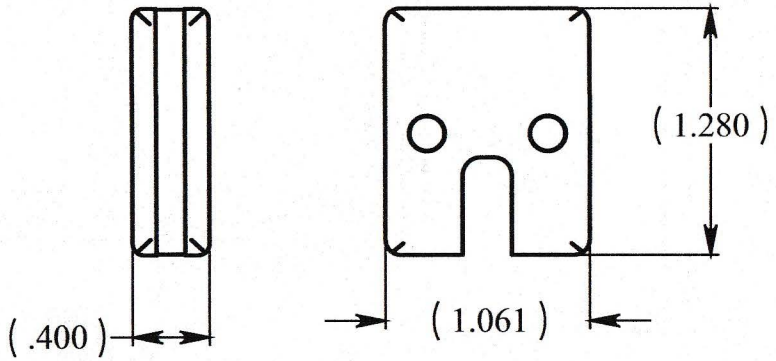
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

MATERIAL: Nylon 6/6	M1A1 Thompson
HEAT TREAT	PART NAME: Buffer
HARDNESS	OPERATION NAME
FINISH: Color - Brown	OPERATION NO. / SCALE: 2:1

Note: After riviting parts together the rivets are to be flush to end plates





ITEM NO.	PART NAME	QTY.
1	Buffer	1
2	Buffer End Plate	2
3	Buffer Rivet	2

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH

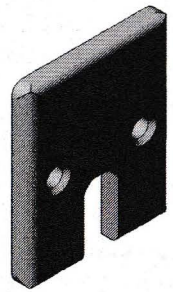
M1A1 Thompson

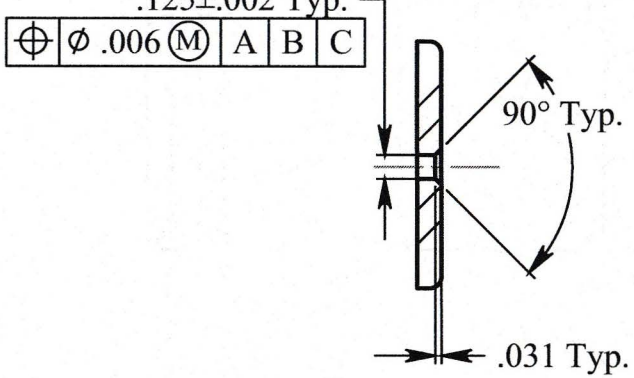
PART NAME: Buffer Assembly

OPERATION NAME

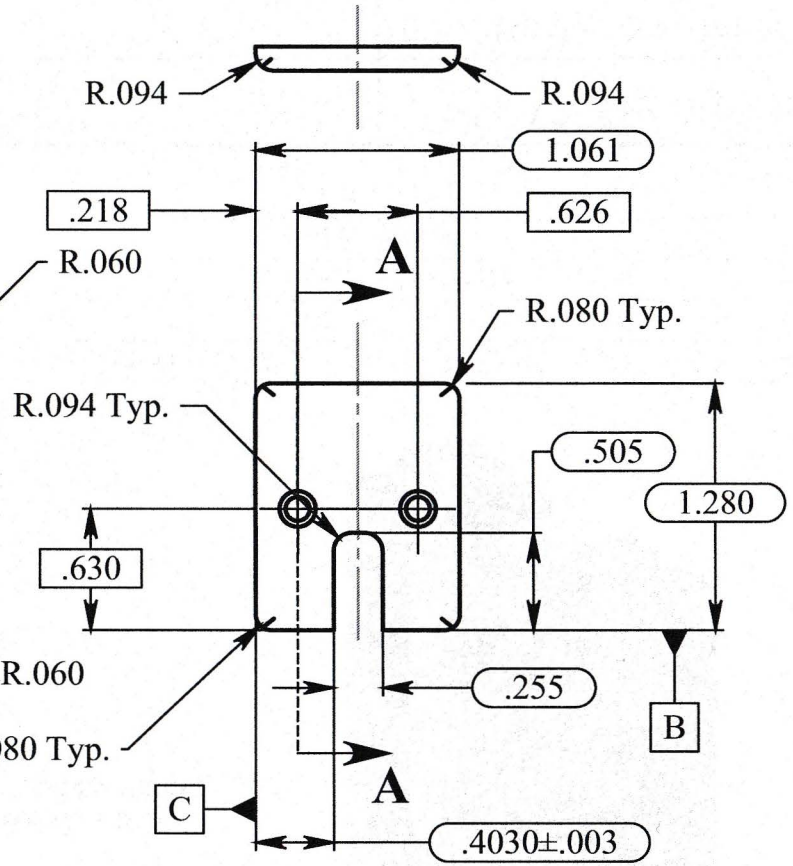
OPERATION NO.

SCALE 1:1





SECTION A-A



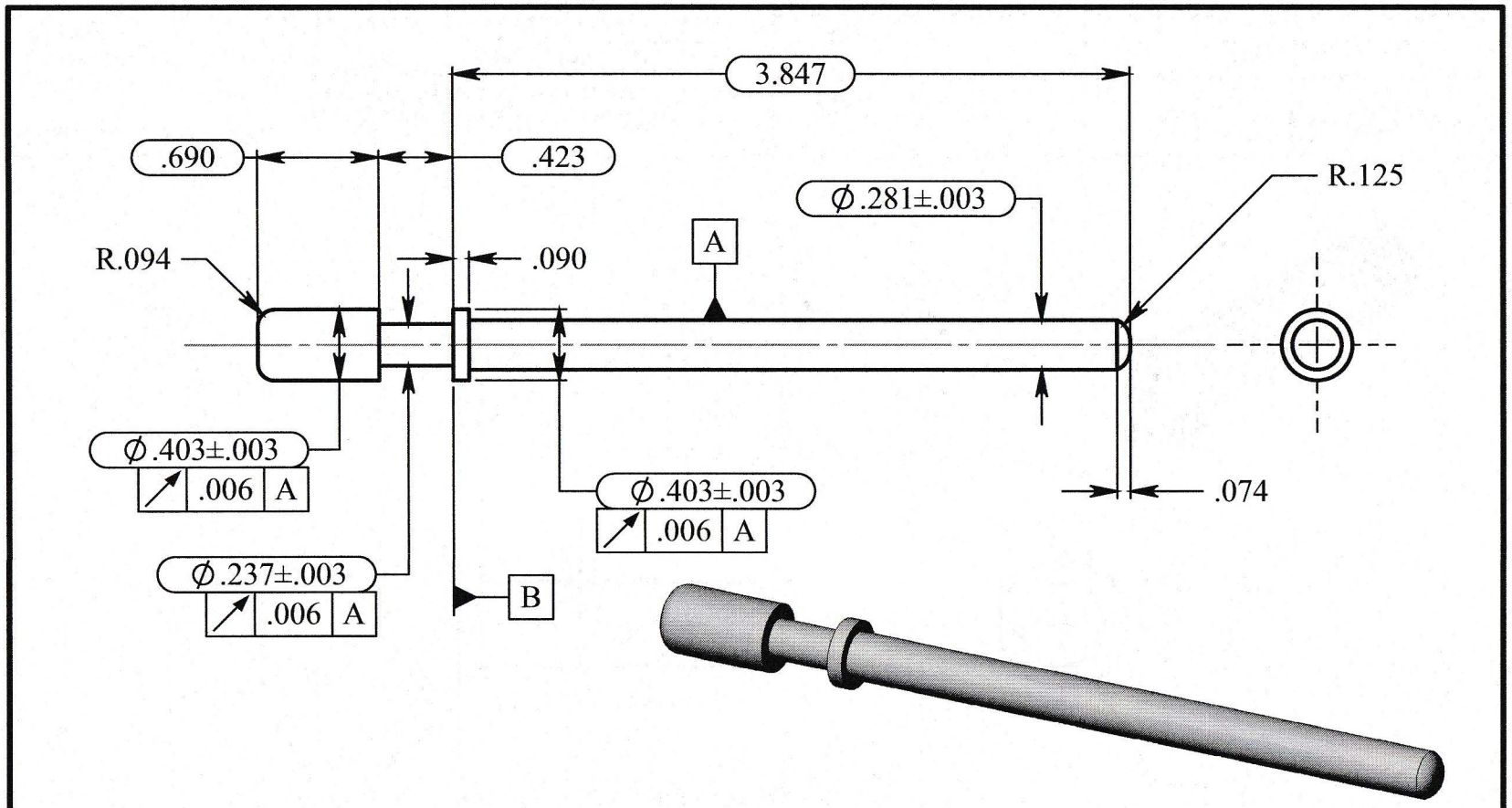
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

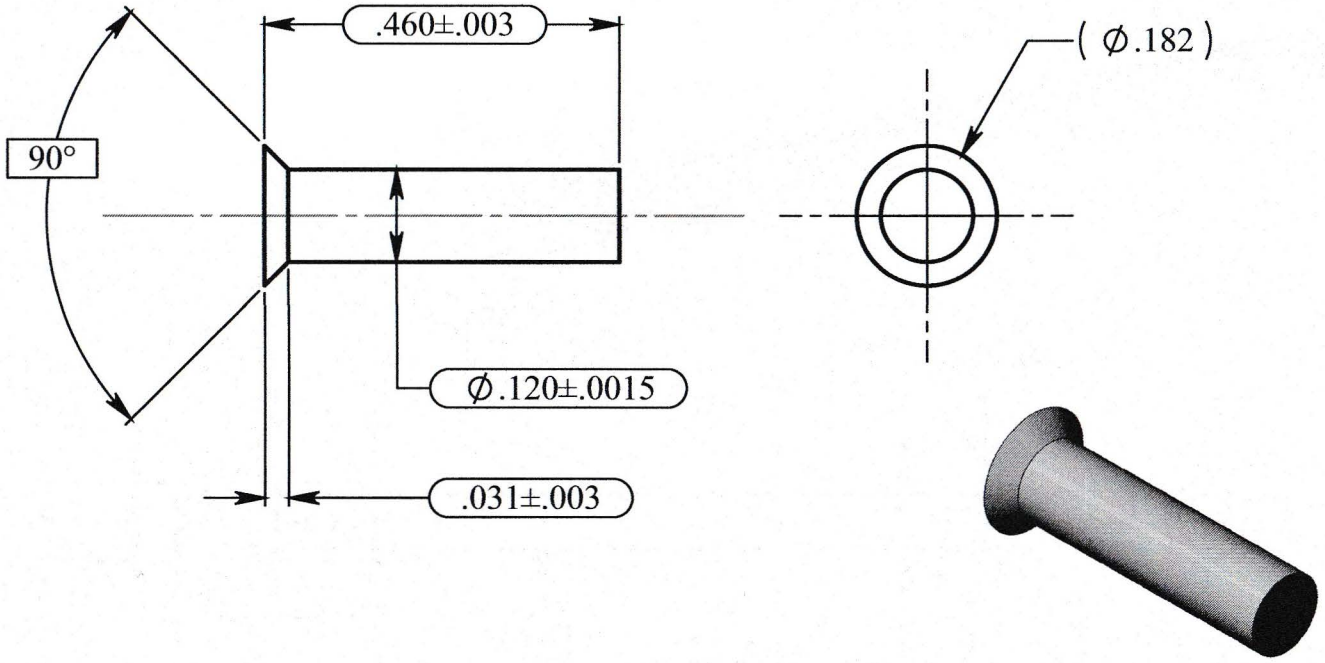
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

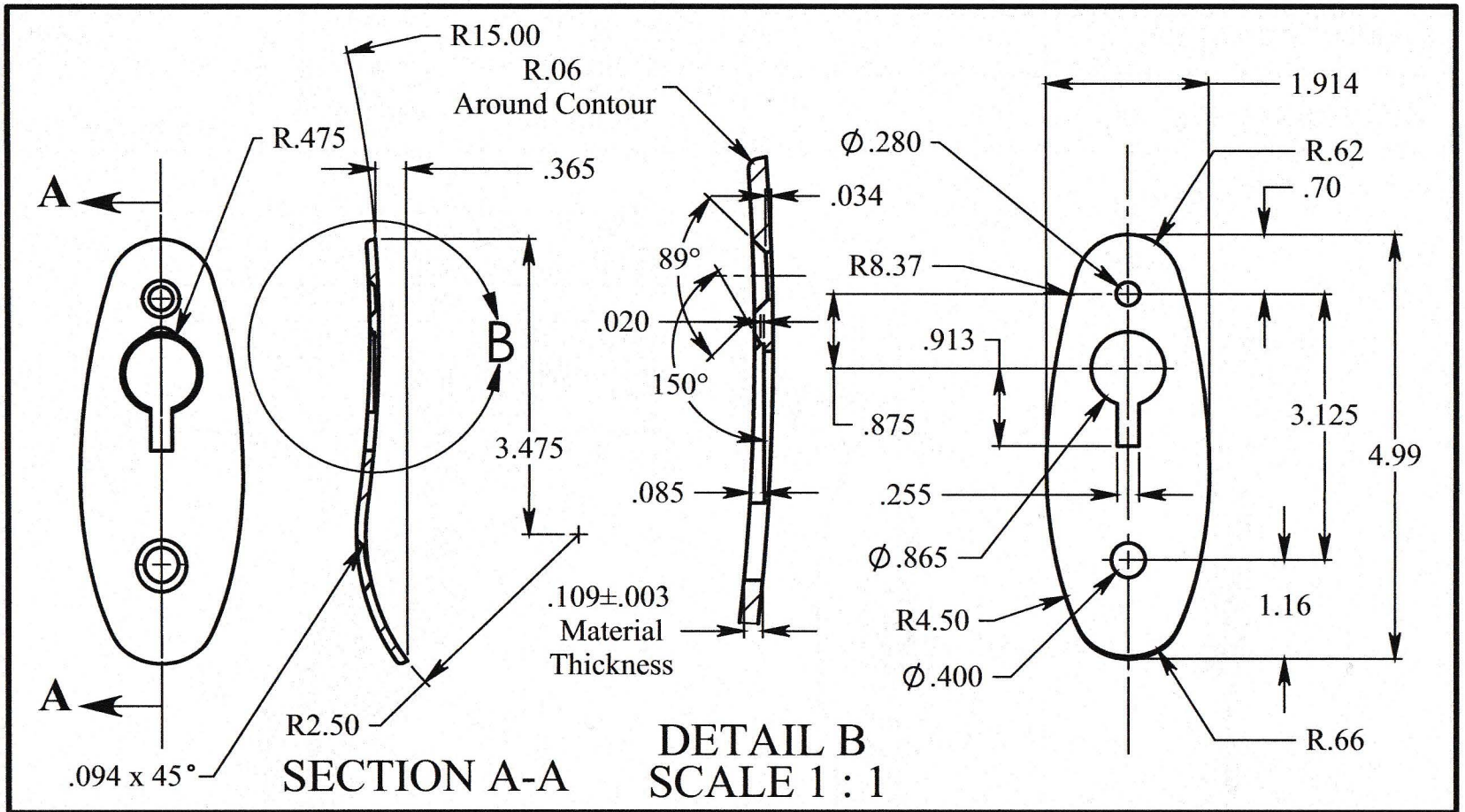
MATERIAL: AISI 1118	M1A1 Thompson
HEAT TREAT: Carburize .75% C	PART NAME: Buffer End Plate
HARDNESS: HR15N 60 - 65	OPERATION NAME:
FINISH: Black Oxide	OPERATION NO.: / SCALE: 1:1



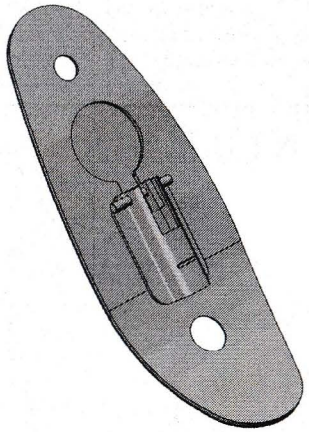
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL: AISI 1118 HEAT TREAT: Carburize .75% C HARDNESS: HR15N 60 - 65 FINISH: Black Oxide	M1A1 Thompson PART NAME: Buffer Pilot OPERATION NAME: OPERATION NO.: SCALE: 1:1

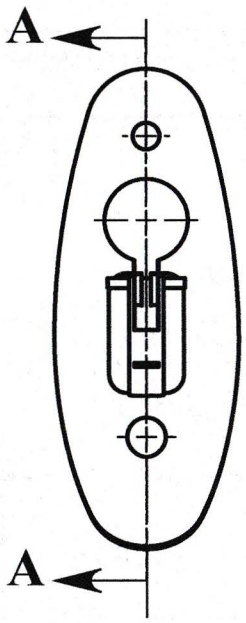


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL AISI 1215	M1A1 Thompson
		HEAT TREAT None	PART NAME Buffer Rivet
		HARDNESS HRB 100 Min.	OPERATION NAME
	Proprietary and Confidential	FINISH None	OPERATION NO. / SCALE 4:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL: AISI 1010 HEAT TREAT: None HARDNESS: HRB 100 Min. FINISH: Maganese Phos.	M1A1 Thompson PART NAME: Butt Plate OPERATION NAME: OPERATION NO.: SCALE: 1:2





SECTION A-A

ITEM NO.	QTY.	PART NUMBER
1	1	Oiler Door
2	1	Butt Plate Sub-Assembly
3	1	Butt Plate Weldment
4	1	Butt Plate
5	1	Oiler Door Pivot Pin
6	1	Oiler Door Spring

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX

2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH

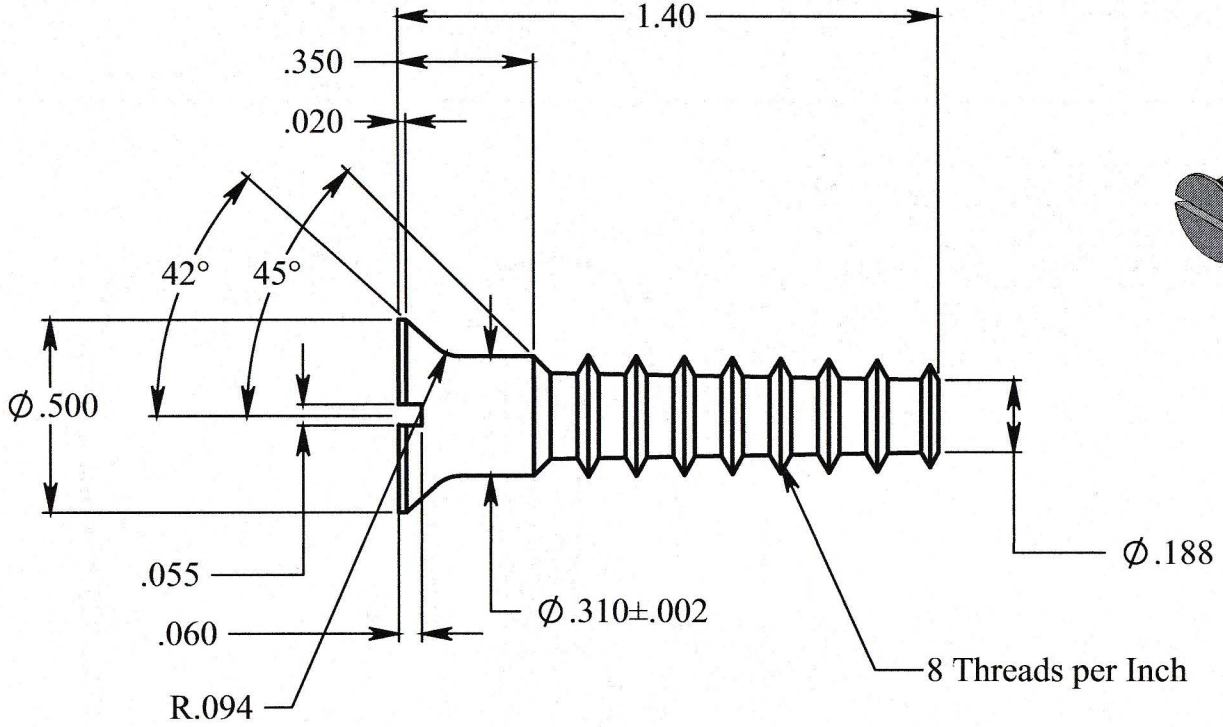
M1A1 Thompson

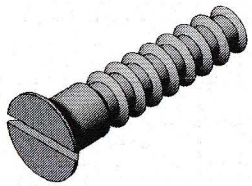
PART NAME
Butt Plate Assembly

OPERATION NAME

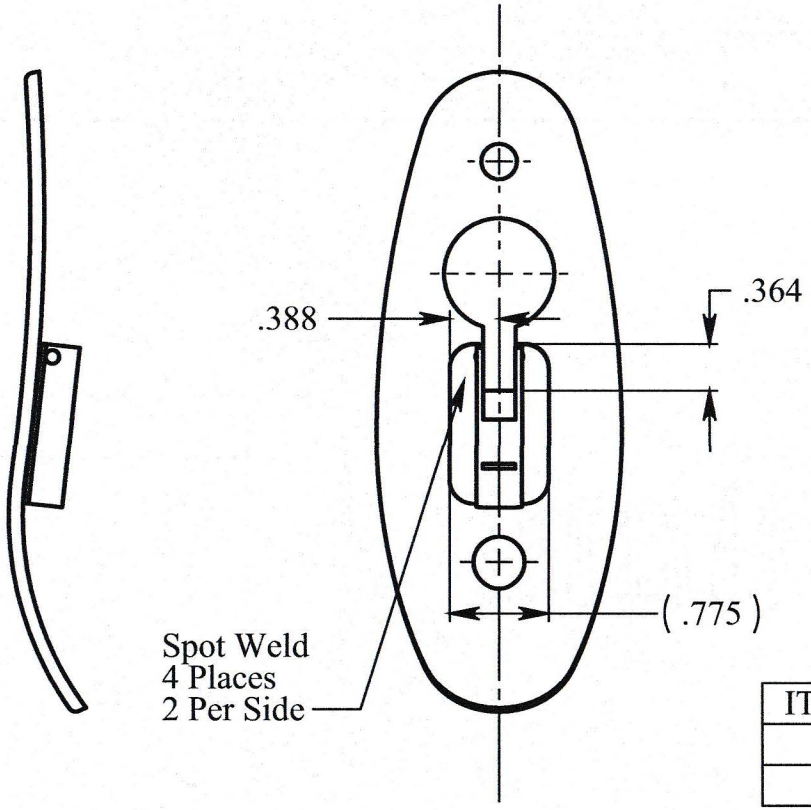
OPERATION NO.

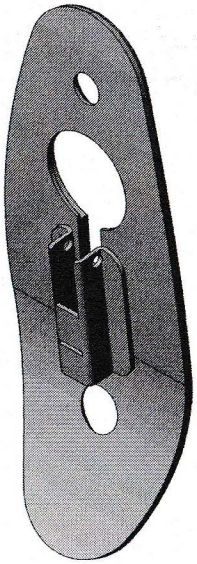
SCALE
1:2





Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Butt Plate Bottom Screw
		HARDNESS	OPERATION NAME
		FINISH	OPERATION NO. / SCALE 2:1
	Proprietary and Confidential		





ITEM NO.	PART NUMBER	QTY.
1	Butt Plate Weldment	1
2	Butt Plate	1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH

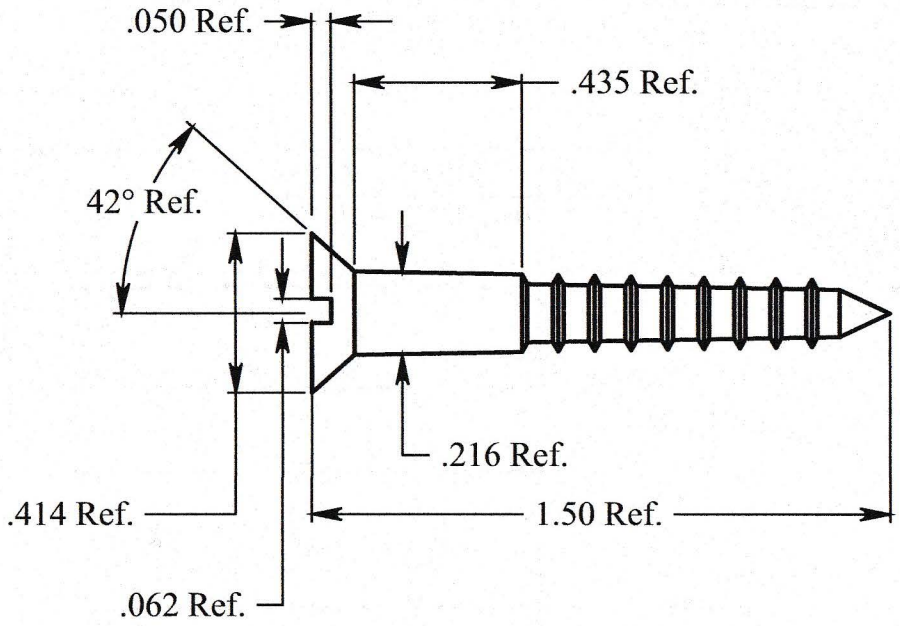
M1A1 Thompson

PART NAME
Butt Plate Sub-Assembly

OPERATION NAME

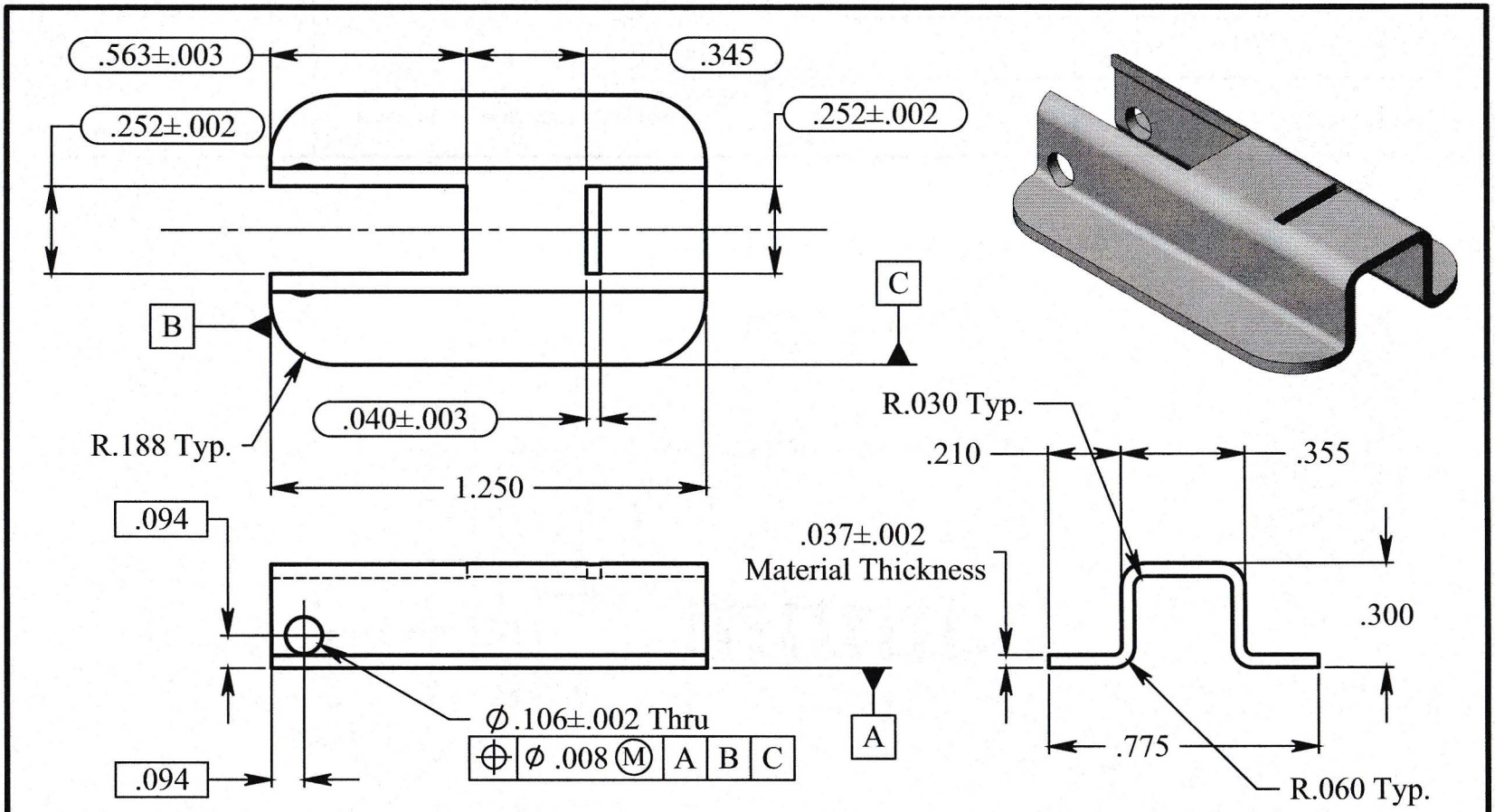
OPERATION NO.

SCALE
3:2



#12 American National Standard Flat Head Wood Screw

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Butt Plate Top Screw OPERATION NAME OPERATION NO. SCALE: 1:2



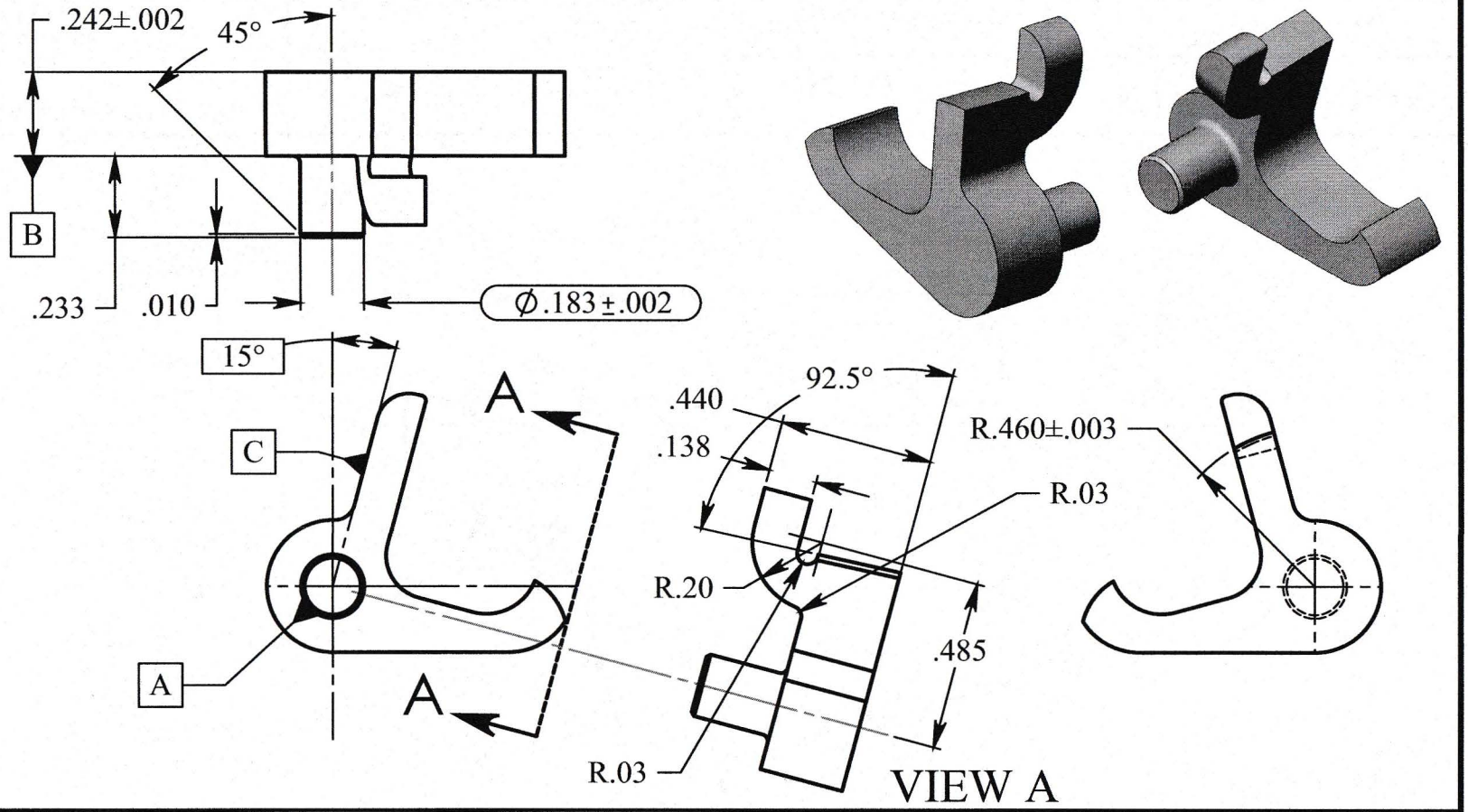
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

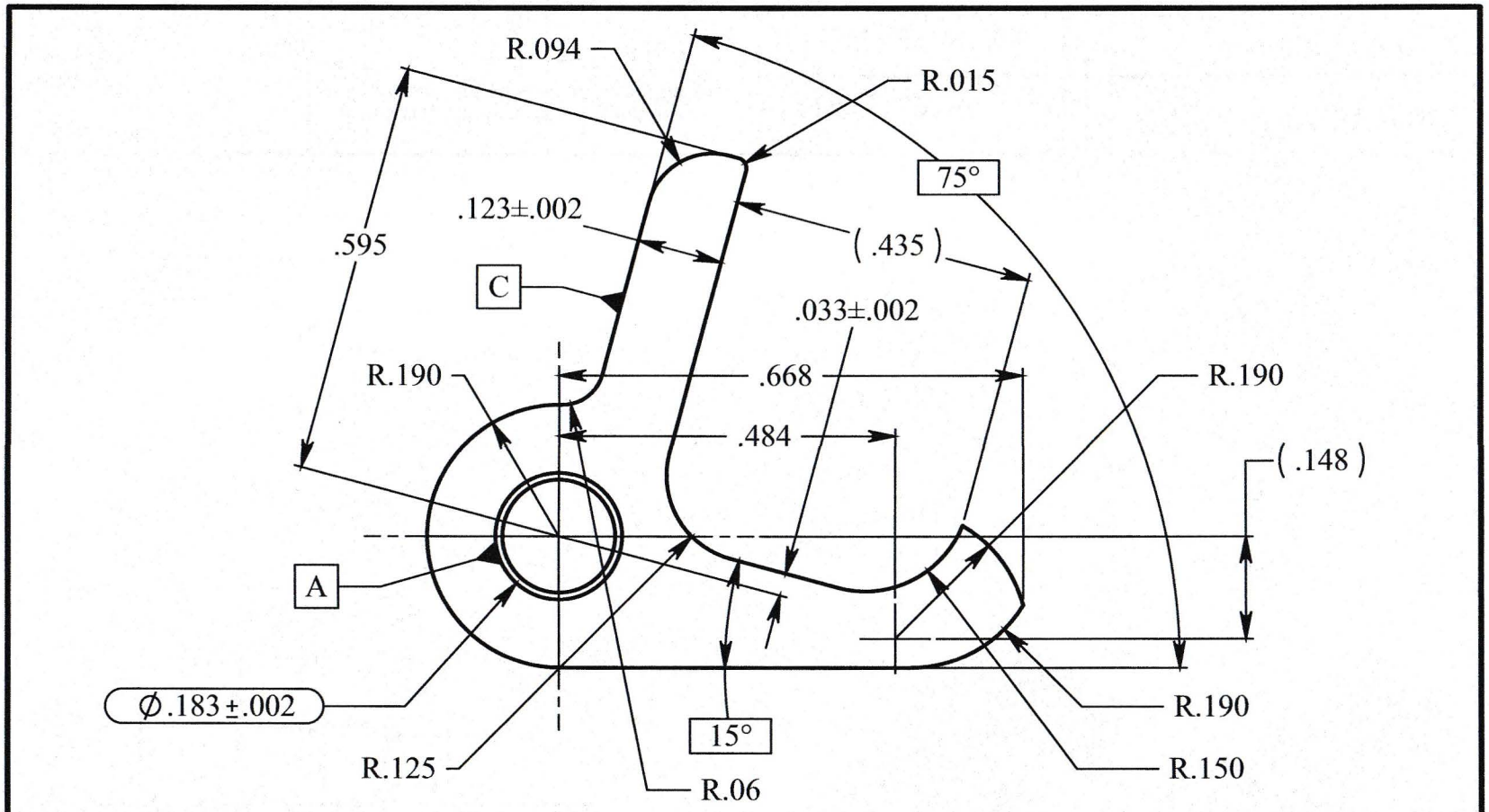
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

MATERIAL: AISI 1010	M1A1 Thompson
HEAT TREAT: None	PART NAME: Butt Plate Weldment
HARDNESS: HRB 100 Min.	OPERATION NAME:
FINISH: None	OPERATION NO.: SCALE: 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 4140	M1A1 Thompson	
		HEAT TREAT Harden &Temper	PART NAME Disconnector	
		HARDNESS HRC 40 - 45	OPERATION NAME Drawing 1	
		FINISH Black Oxide	OPERATION NO.	SCALE 2:1
	Proprietary and Confidential			



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 4140	M1A1 Thompson
		HEAT TREAT Harden &Temper	PART NAME Disconnector
		HARDNESS HRC 40 - 45	OPERATION NAME Drawing 2
	Proprietary and Confidential	FINISH Black Oxide	OPERATION NO. SCALE 4:1

Manufaturing Data:

Spring Type:	Helical Compression
Outside Diameter:	.236 inches
Wire Diameter:	.030 inches
Total Coils:	10.0
Active Coils:	8.0
Coil Type:	Closed, Not Ground
Free Length:	.625
Wind Direction:	Either Hand

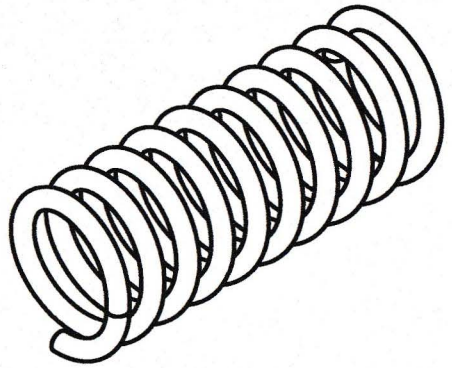
Inspection Data:

Load Length L1:	.470 inches
Load P1:	2.6 +/-.7 lbs.
Load Length L2:	.345 inches
Loap P2:	4.65 lbs +/-.75 lbs.
Max. Solid Height:	.340 inches

Spring works in a .250 diameter hole
Spring works over a .000 diameter rod

Engineering Data:

Spring Rate:	16.6 lbs/in.
Spring Index:	6.9
Static Solid Stress:	116,175 psi
Stress Percentage:	35%



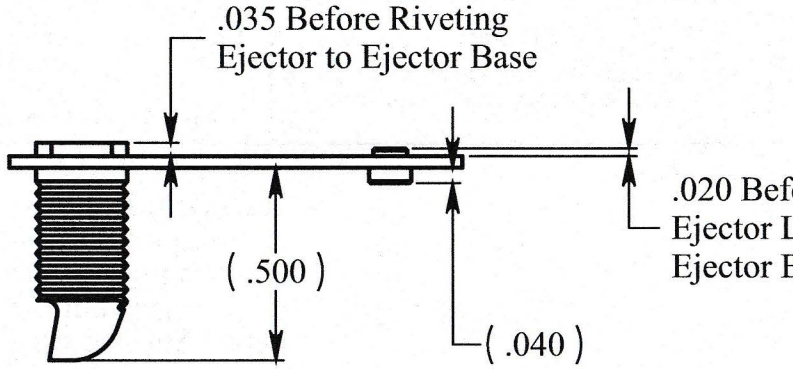
Dimensions are in Inches

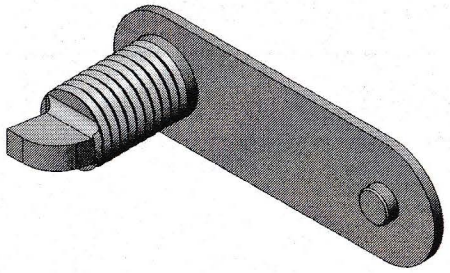
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

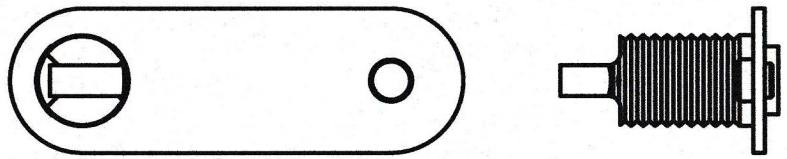
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: ASTM A228 Music Wire	M1A1 Thompson	
HEAT TREAT: Stress Relieve	PART NAME: Disconnector Spring	
HARDNESS:	OPERATION NAME:	
FINISH: None	OPERATION NO.:	SCALE: 4:1







ITEM NO.	PART NUMBER	QTY.
1	Ejector Base	1
2	Ejector Post	1
3	Ejector Locator Pin	1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH: Black Oxide

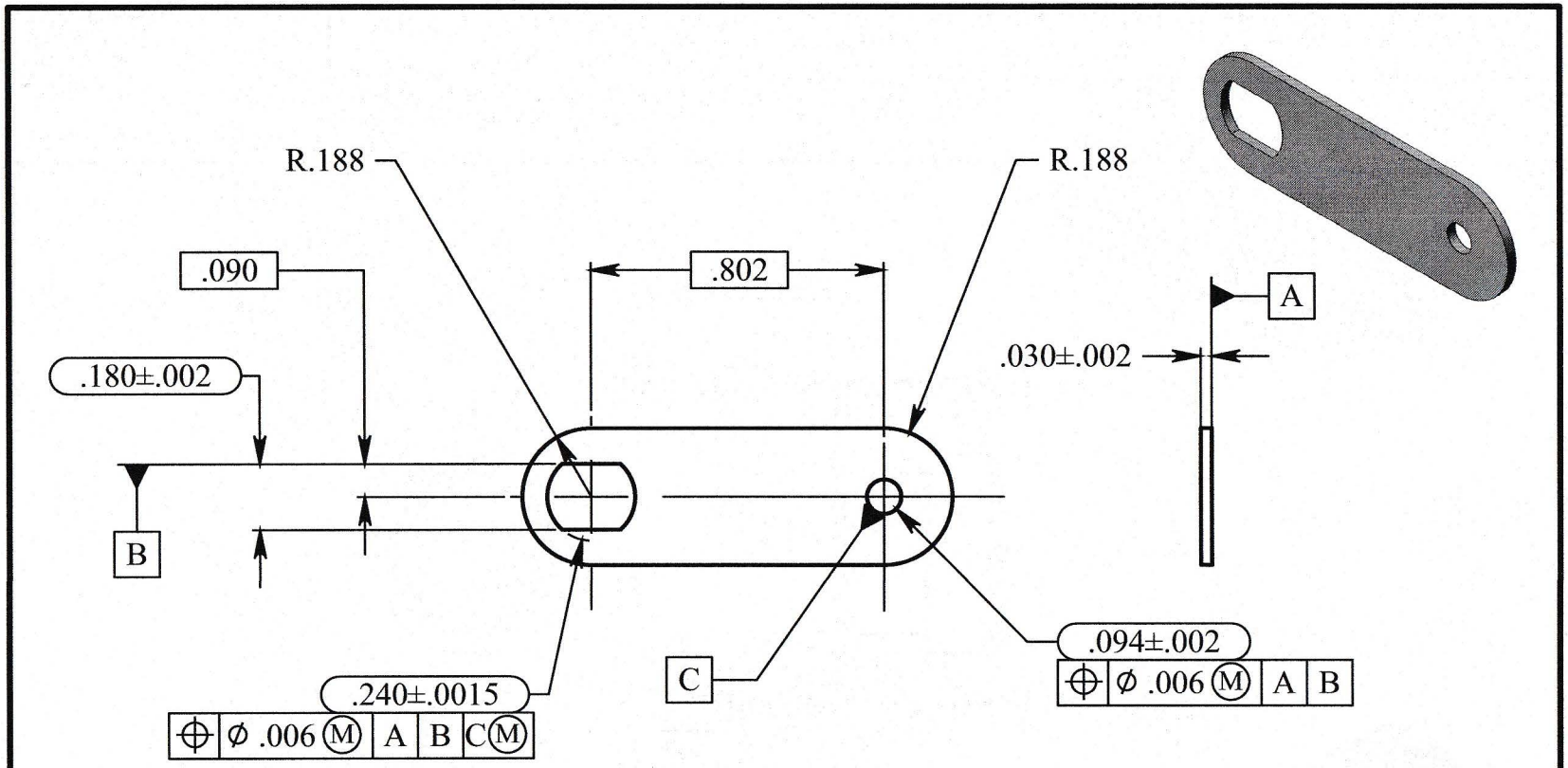
M1A1 Thompson

PART NAME: Ejector Assembly

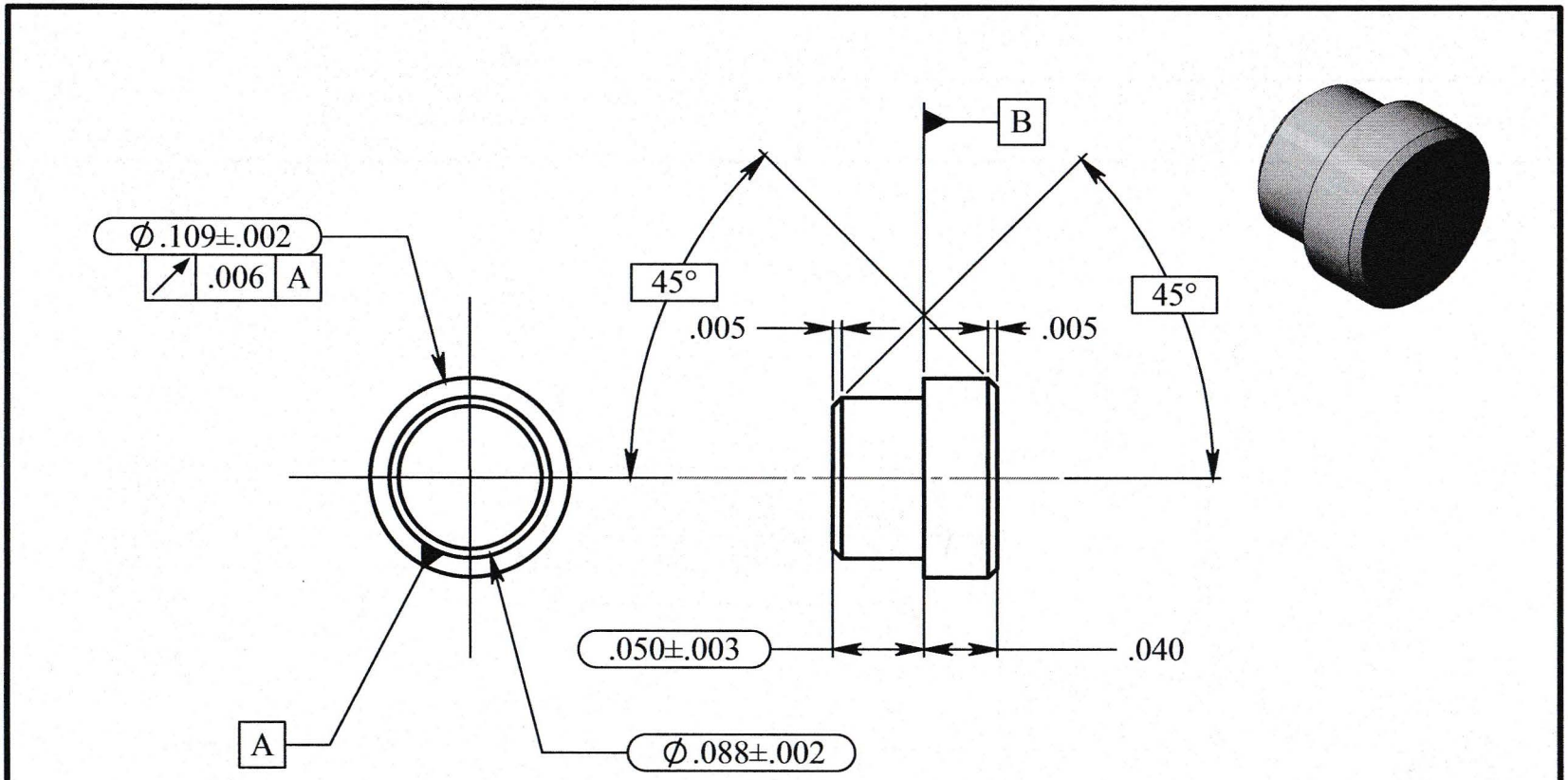
OPERATION NAME

OPERATION NO.

SCALE: 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL: AISI 1095 HEAT TREAT: Harden &Temper HARDNESS: HRC 48 - 53 FINISH: None	M1A1 Thompson PART NAME: Ejector Base OPERATION NAME: OPERATION NO.: SCALE: 2:1



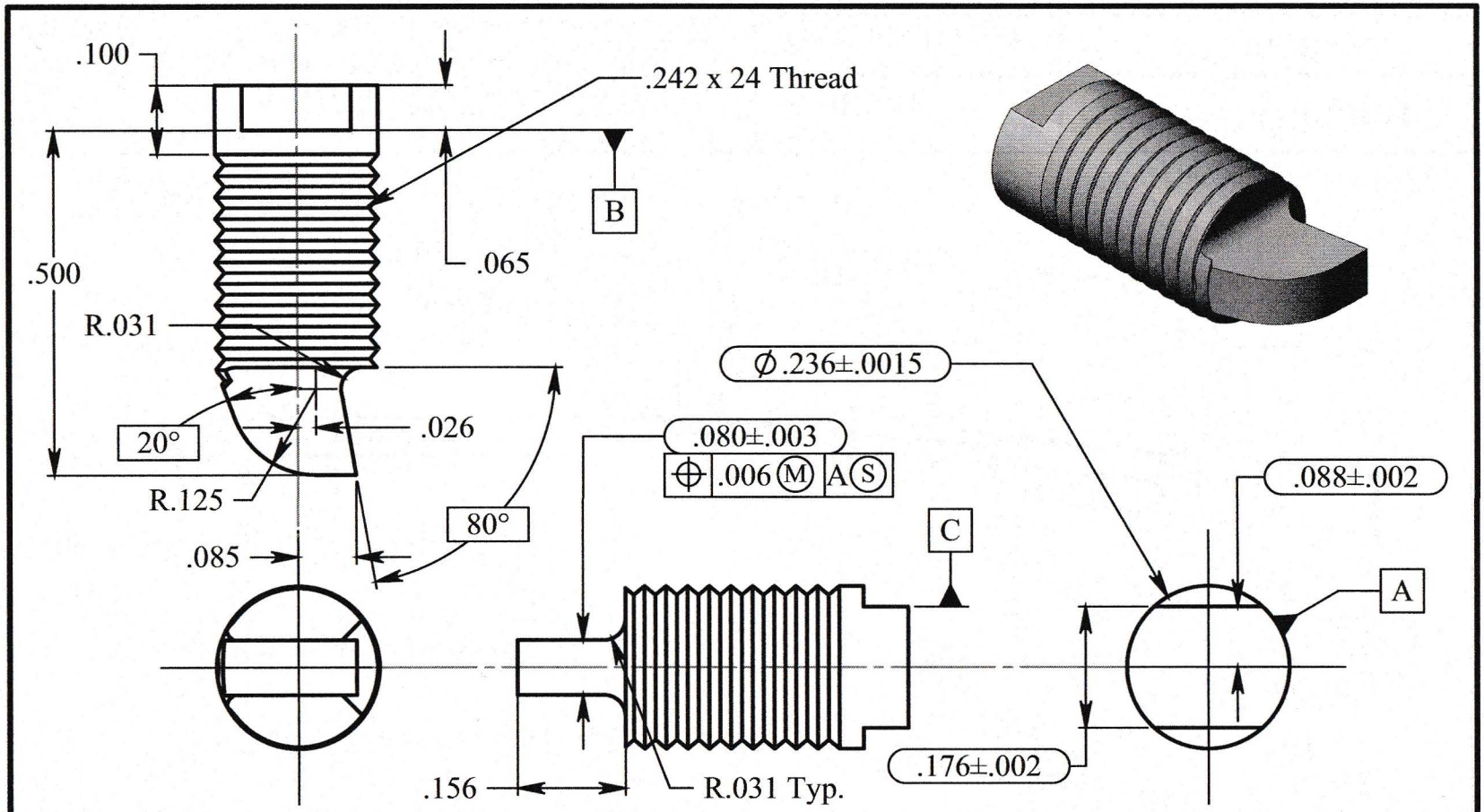
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

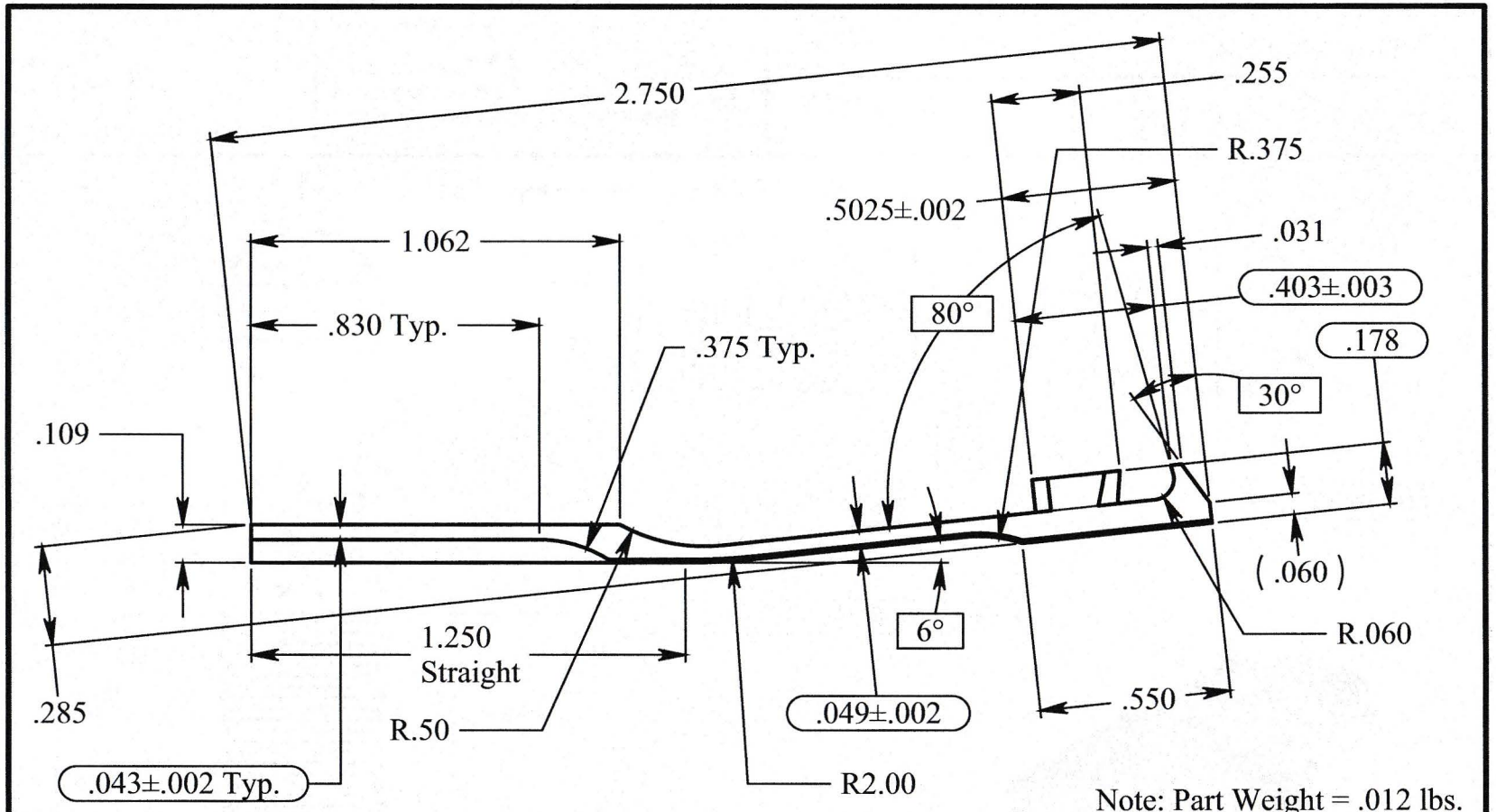
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1118	M1A1 Thompson
HEAT TREAT: None	PART NAME: Ejector Locating Pin
HARDNESS: HRB 100 Min.	OPERATION NAME:
FINISH: None	OPERATION NO.: / SCALE: 10:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL: AISI 4140 HEAT TREAT: None HARDNESS: HRB 100 Min. FINISH: None	M1A1 Thompson PART NAME: Ejector Post OPERATION NAME: OPERATION NO.: SCALE: 4:1



Note: Part Weight = .012 lbs.

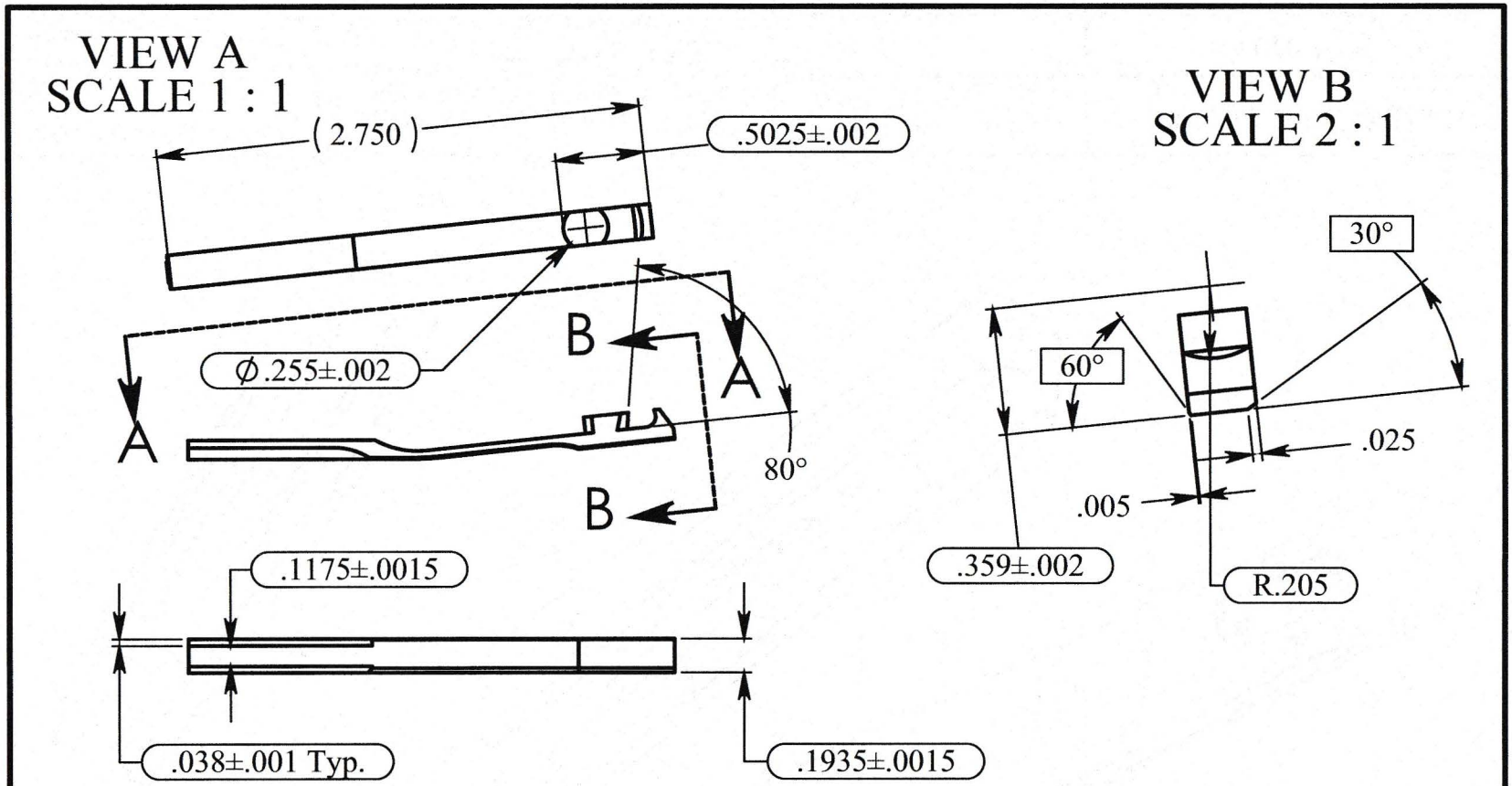
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

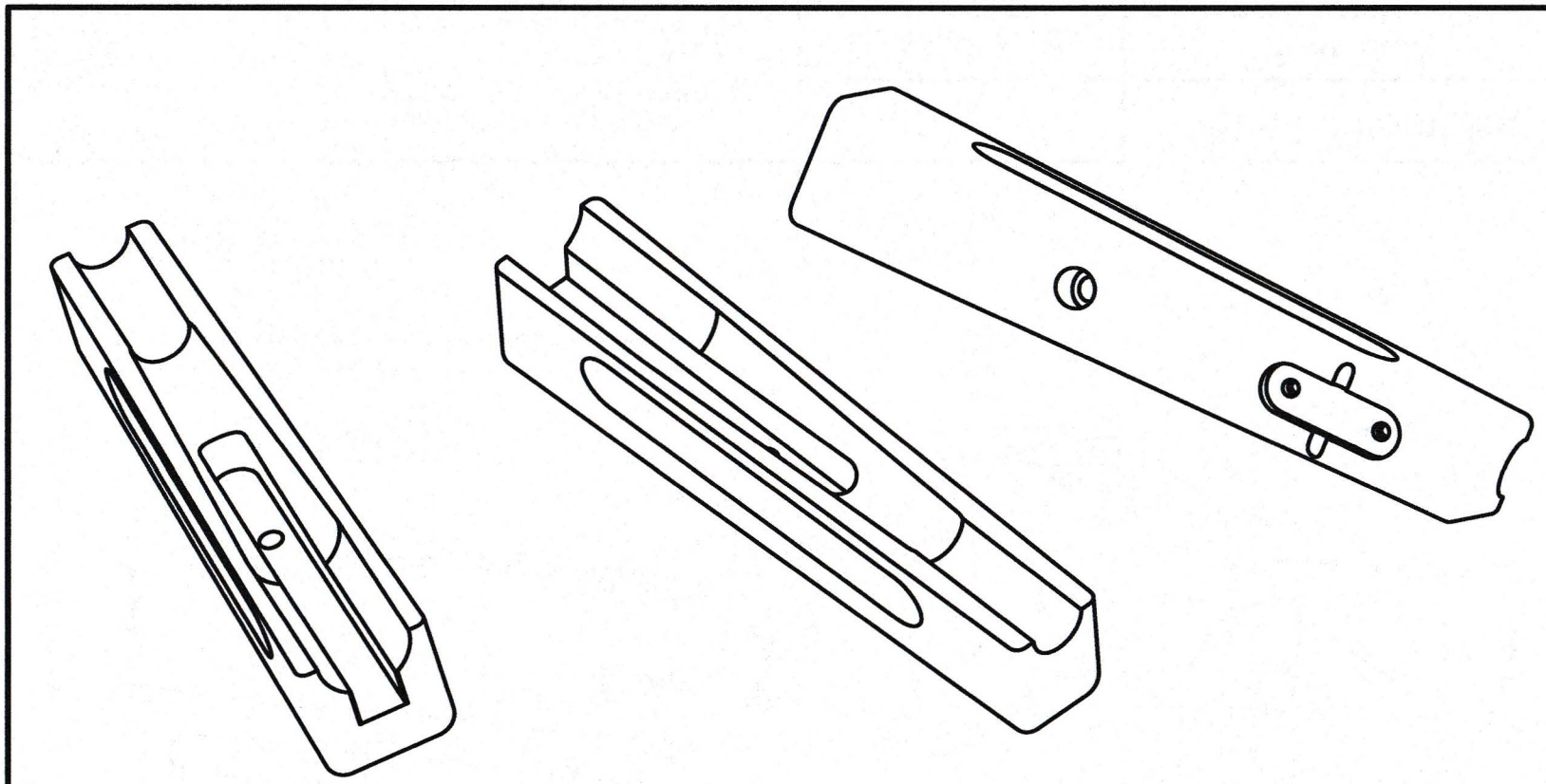
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1095	M1A1 Thompson
HEAT TREAT: Harden &Temper	PART NAME: Extractor
HARDNESS: HRC 48 - 53	OPERATION NAME: Drawing 1
FINISH: Black Oxide	OPERATION NO. / SCALE: 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 1095	M1A1 Thompson	
		HEAT TREAT Harden &Temper	PART NAME Extractor	
		HARDNESS HRC 48 - 53	OPERATION NAME Drawing 2	
		FINISH Black Oxide	OPERATION NO.	SCALE 1:1
	Proprietary and Confidential			



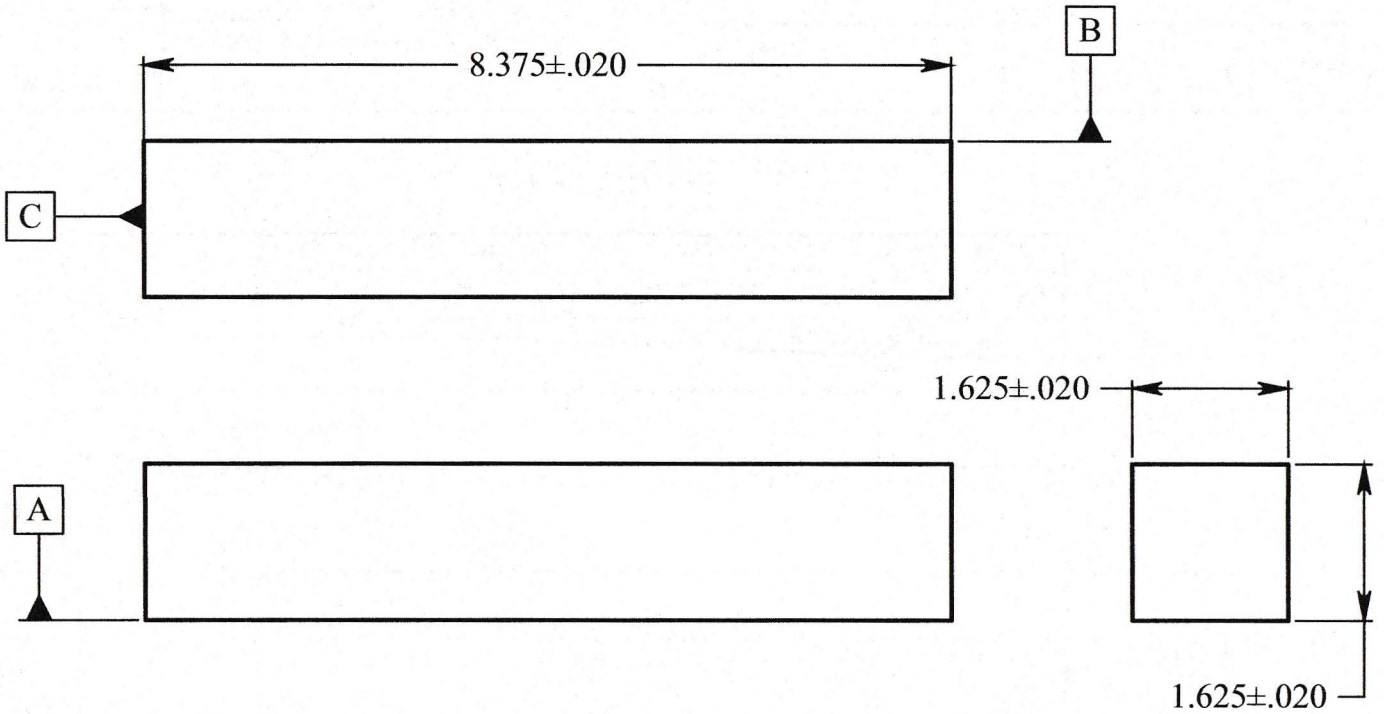
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

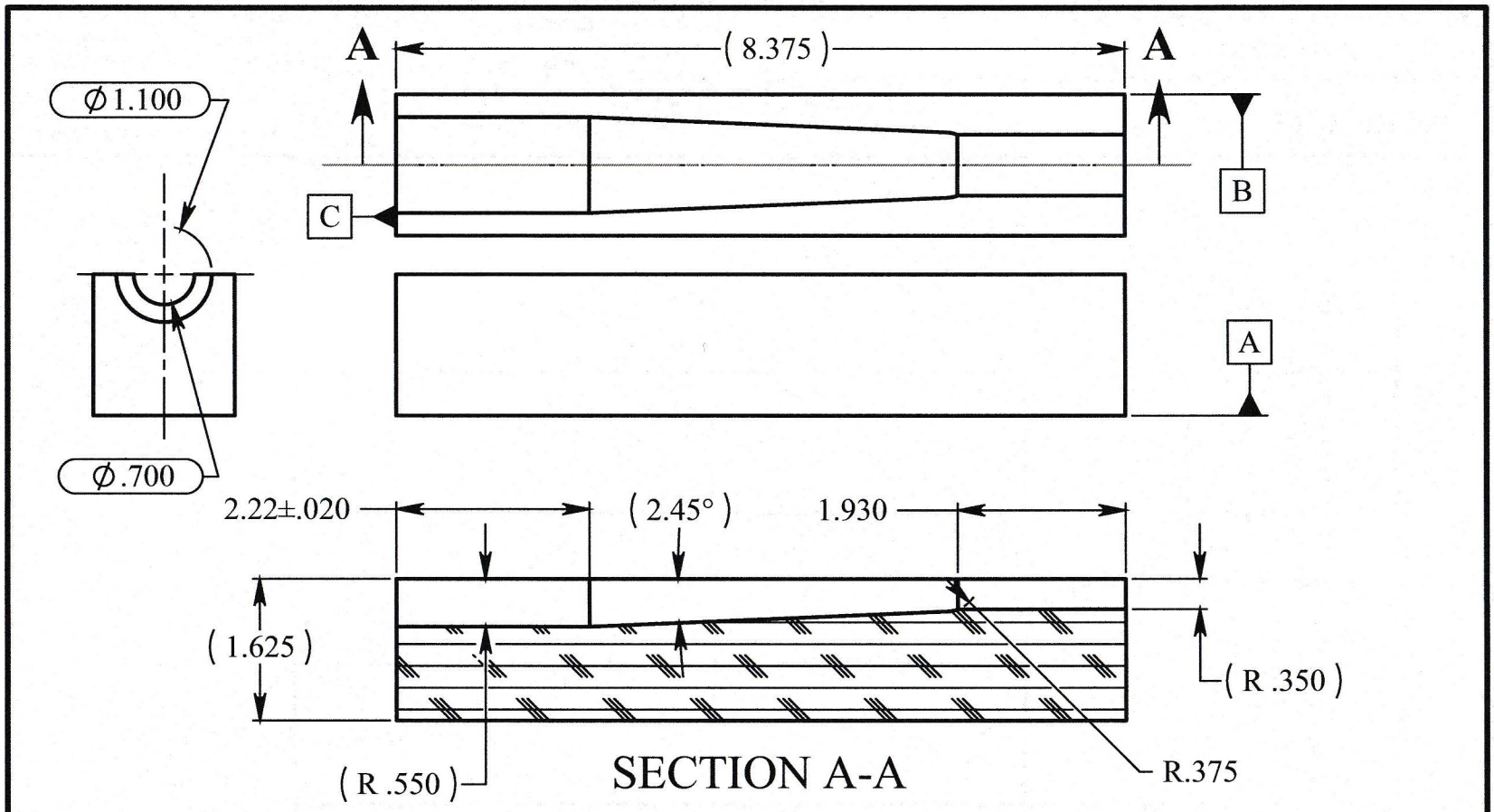
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

MATERIAL: Walnut	M1A1 Thompson
HEAT TREAT	PART NAME: Fore End
HARDNESS	OPERATION NAME
FINISH	OPERATION NO. / SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX Proprietary and Confidential	MATERIAL: Walnut HEAT TREAT: HARDNESS: FINISH:	M1A1 Thompson PART NAME: Fore End OPERATION NAME: Blank OPERATION NO.: 5 SCALE: 1:2



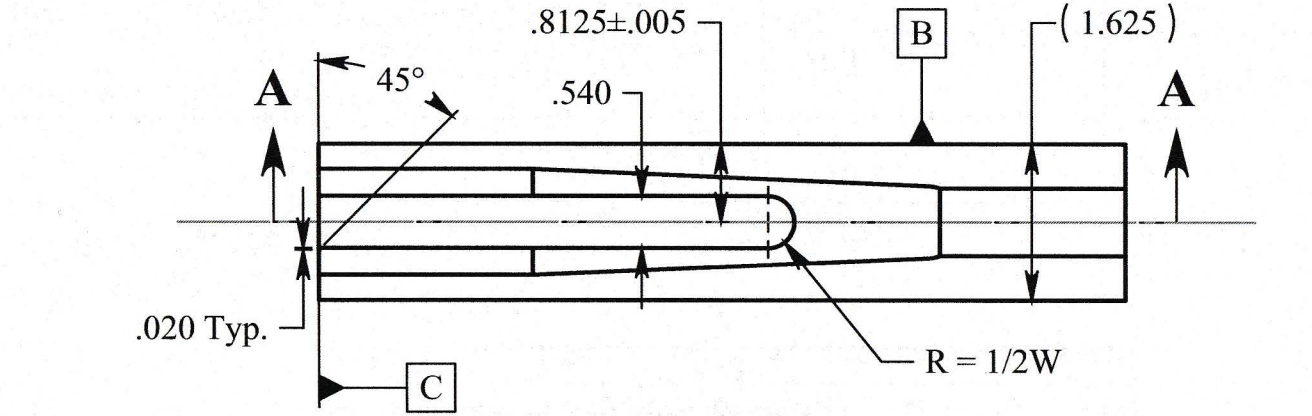
Dimensions are in Inches

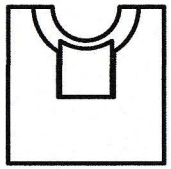
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

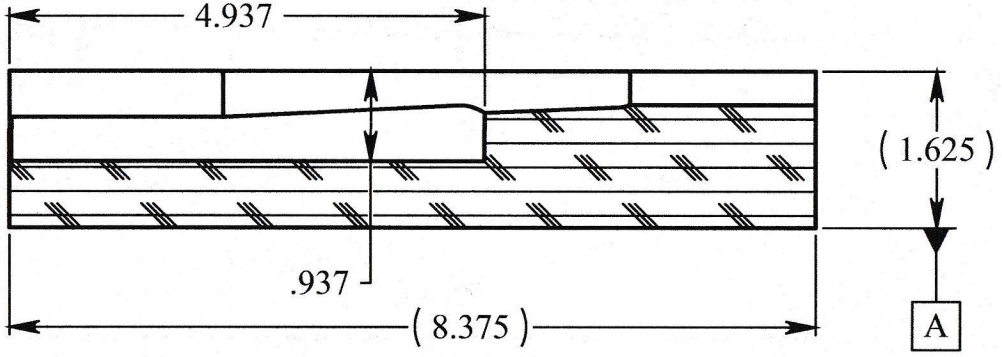
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: Walnut	M1A1 Thompson
HEAT TREAT	PART NAME: Fore End
HARDNESS	OPERATION NAME: Barrel Groove
FINISH	OPERATION NO.: 10
	SCALE: 1:2

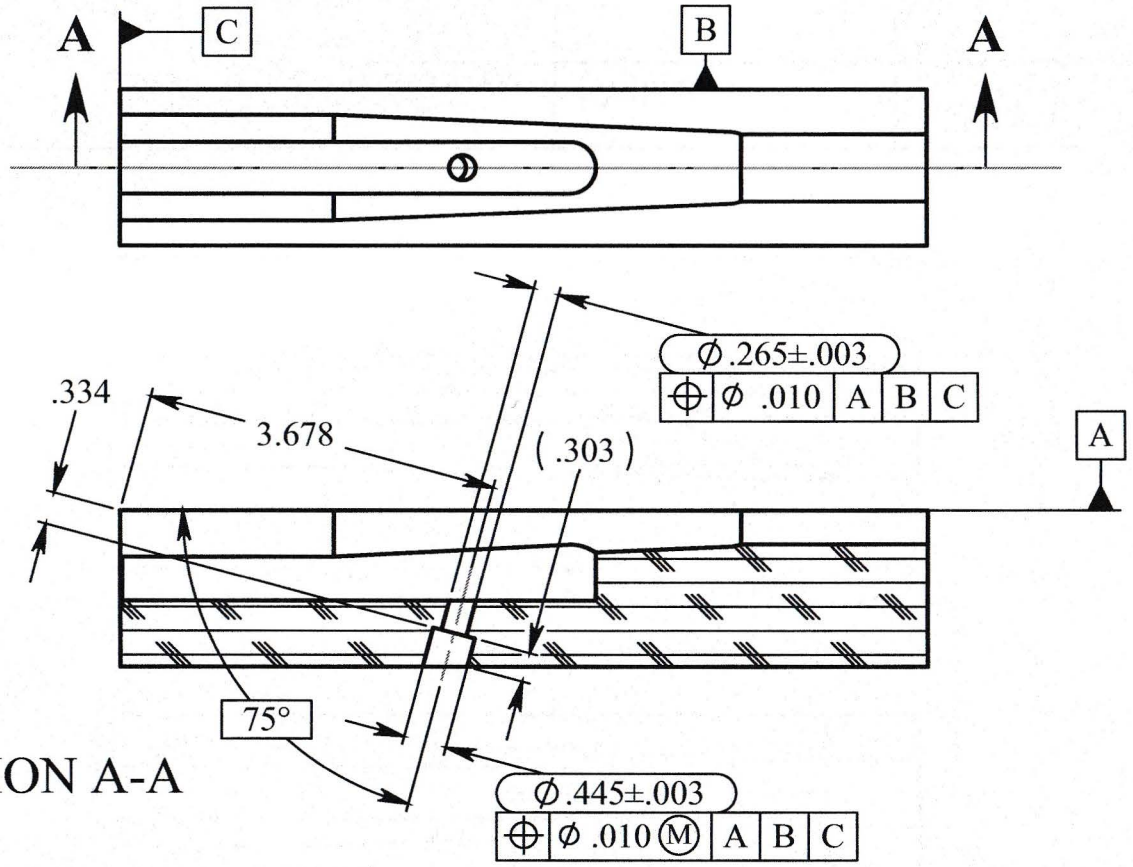






SECTION A-A

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL: Walnut HEAT TREAT: HARDNESS: FINISH:	M1A1 Thompson PART NAME: Fore End OPERATION NAME: Iron Cut OPERATION NO.: 20 SCALE: 1:2



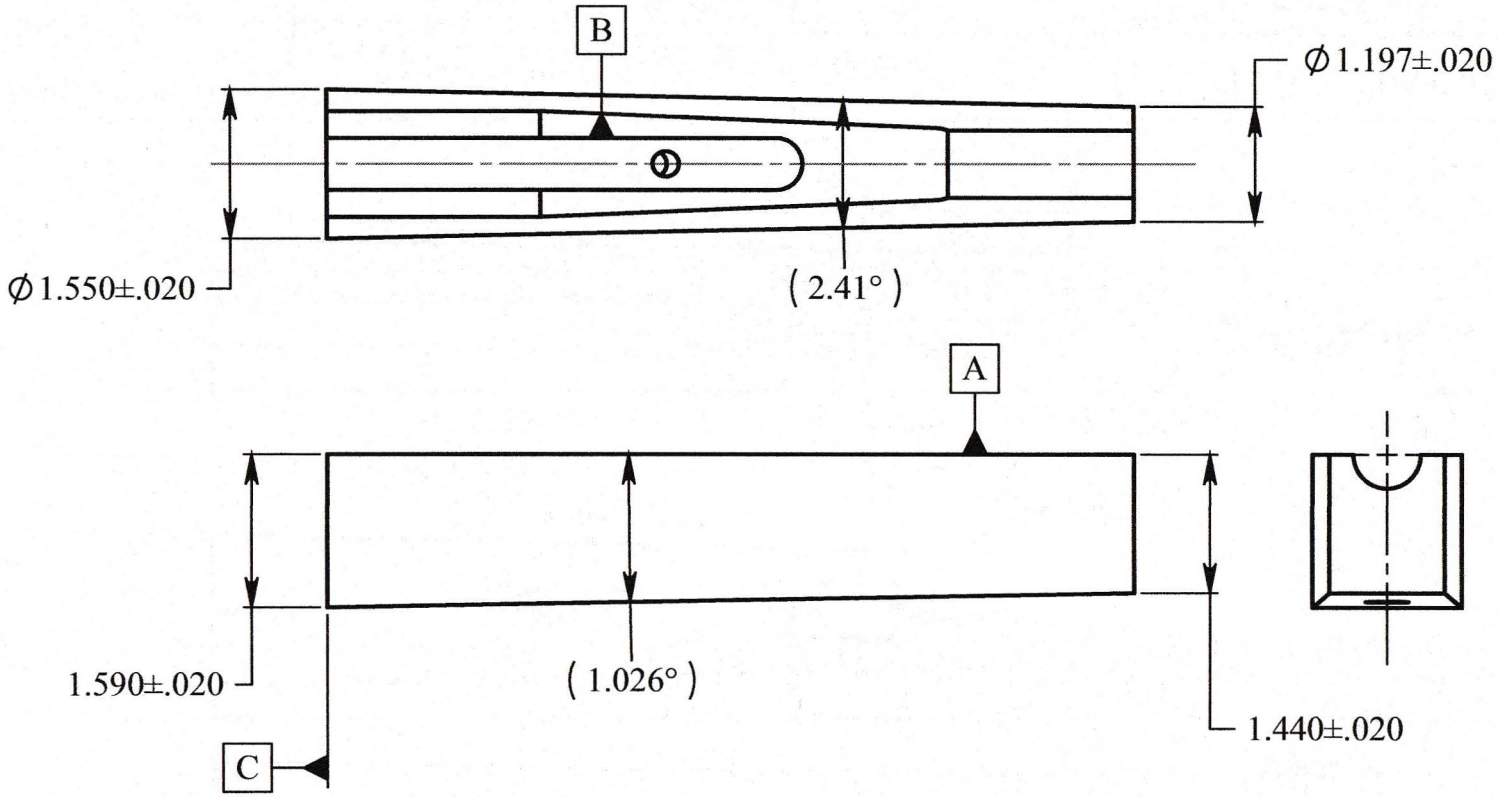
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: Walnut	M1A1 Thompson
HEAT TREAT:	PART NAME: Fore End
HARDNESS:	OPERATION NAME: Retaining Screw Hole
FINISH:	OPERATION NO.: 30 / SCALE: 1:2



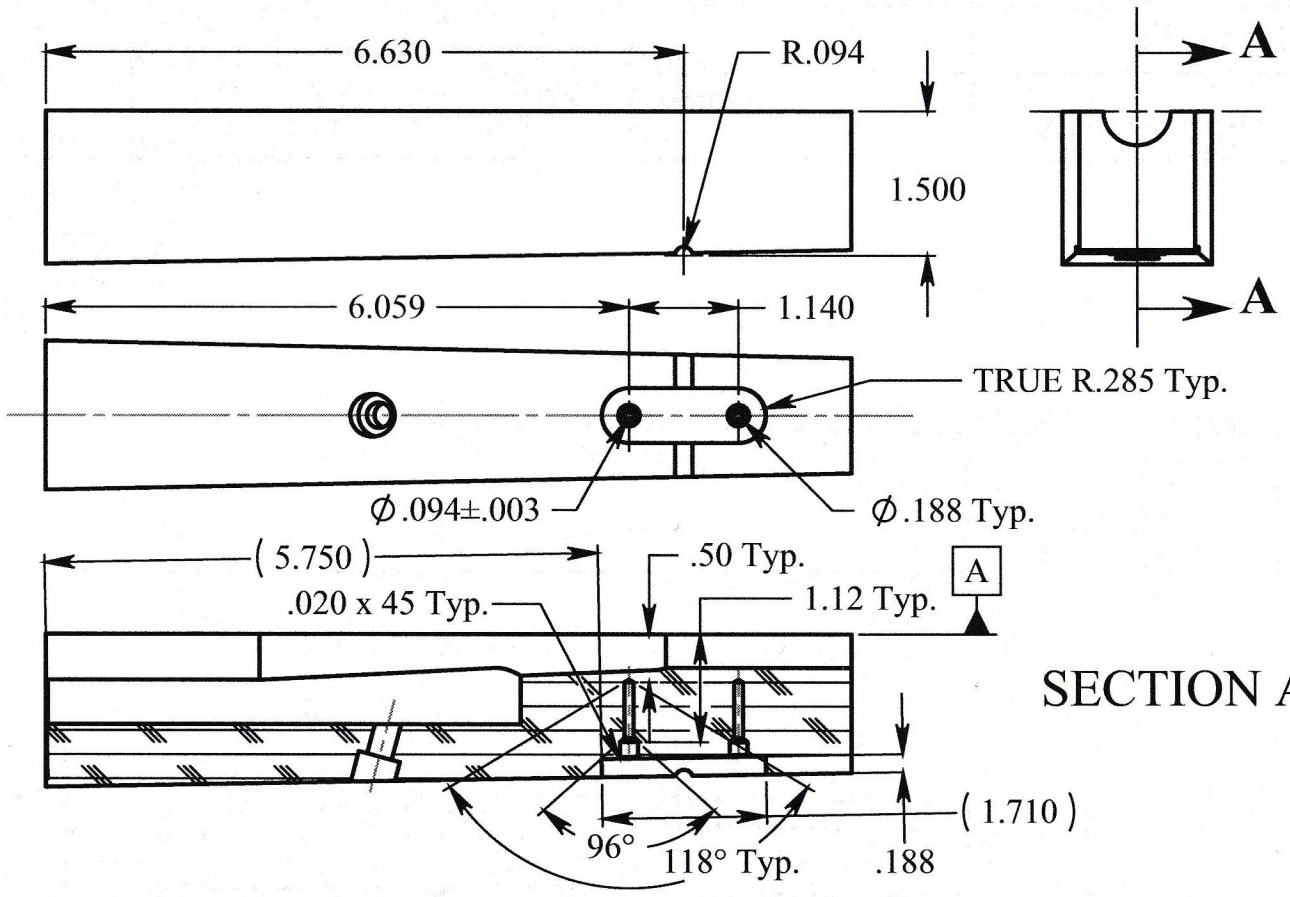
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: Walnut	M1A1 Thompson
HEAT TREAT	PART NAME: Fore End
HARDNESS	OPERATION NAME: Side & Bottom Cuts
FINISH	OPERATION NO.: 40 — SCALE: 1:2



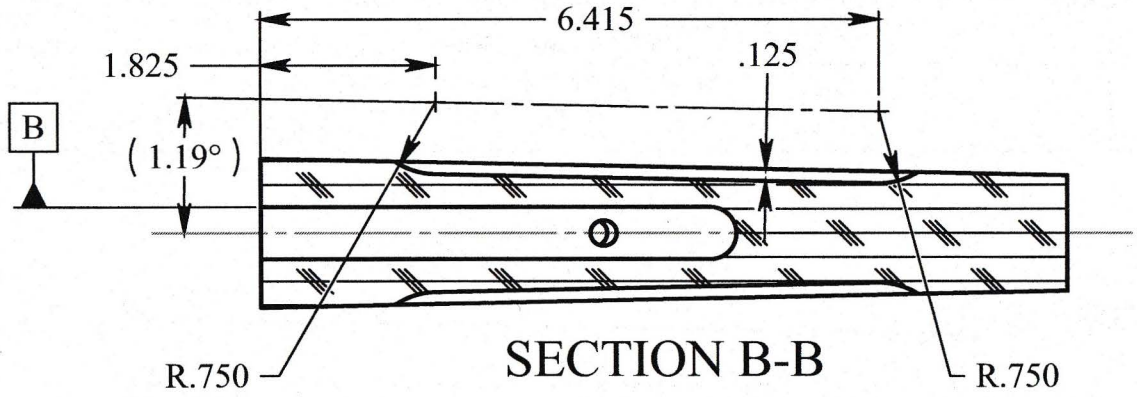
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

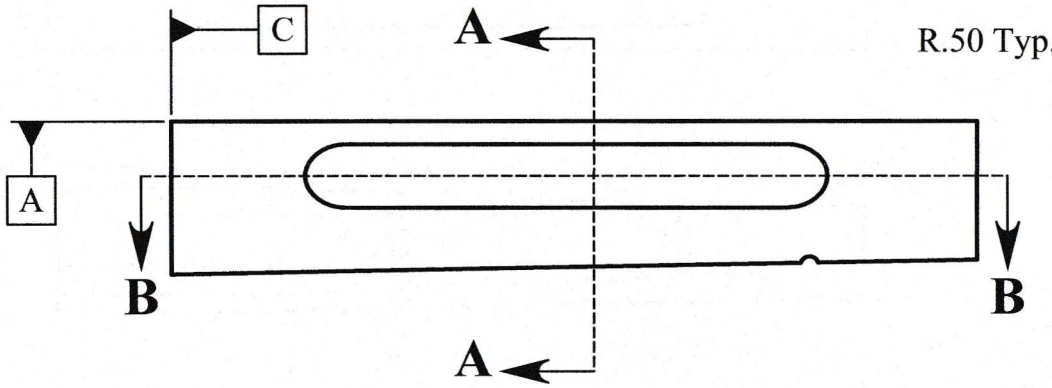
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

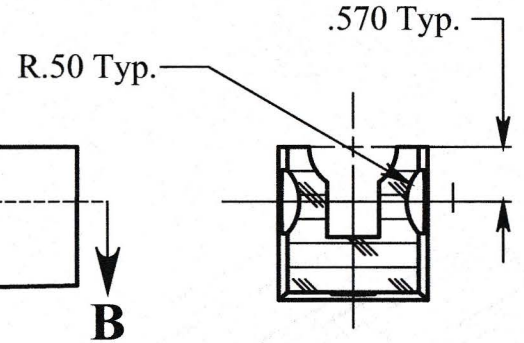
Proprietary and Confidential

MATERIAL: Walnut	M1A1 Thompson
HEAT TREAT	PART NAME: Fore End
HARDNESS	OPERATION NAME: Sling Swivel Cuts
FINISH	OPERATION NO.: 50
	SCALE: 1:2



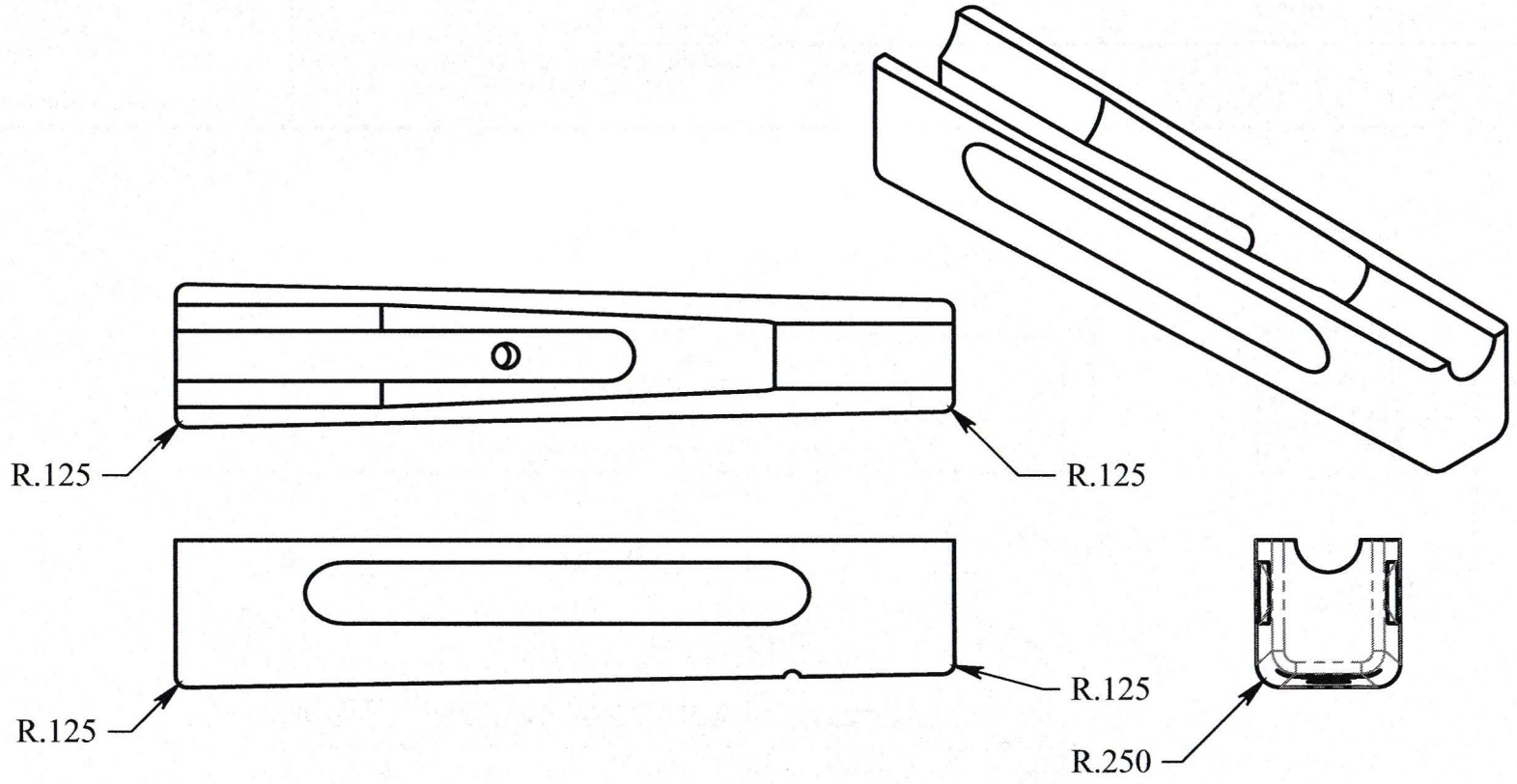
SECTION B-B



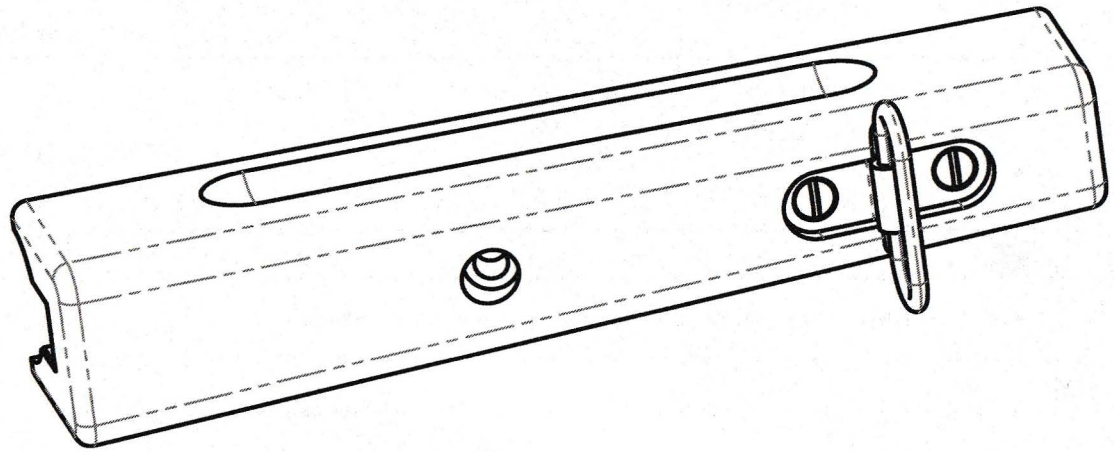


SECTION A-A

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL Walnut	M1A1 Thompson
		HEAT TREAT	PART NAME Fore End
		HARDNESS	OPERATION NAME Finger Grooves
		FINISH	OPERATION NO. 60 — SCALE 1:2
	Proprietary and Confidential		



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX	MATERIAL Walnut	M1A1 Thompson
		HEAT TREAT	PART NAME Fore End
		HARDNESS	OPERATION NAME Finishing
		FINISH Stain and Oil Finish	OPERATION NO. 70 / SCALE 1:2
	Proprietary and Confidential		



ITEM NO.	PART NUMBER	QTY.
1	Fore End	1
2	Sling Swivel Base	1
3	Sling Swivel Loop	1
4	Sling Swivel Ret. Screw	2

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH

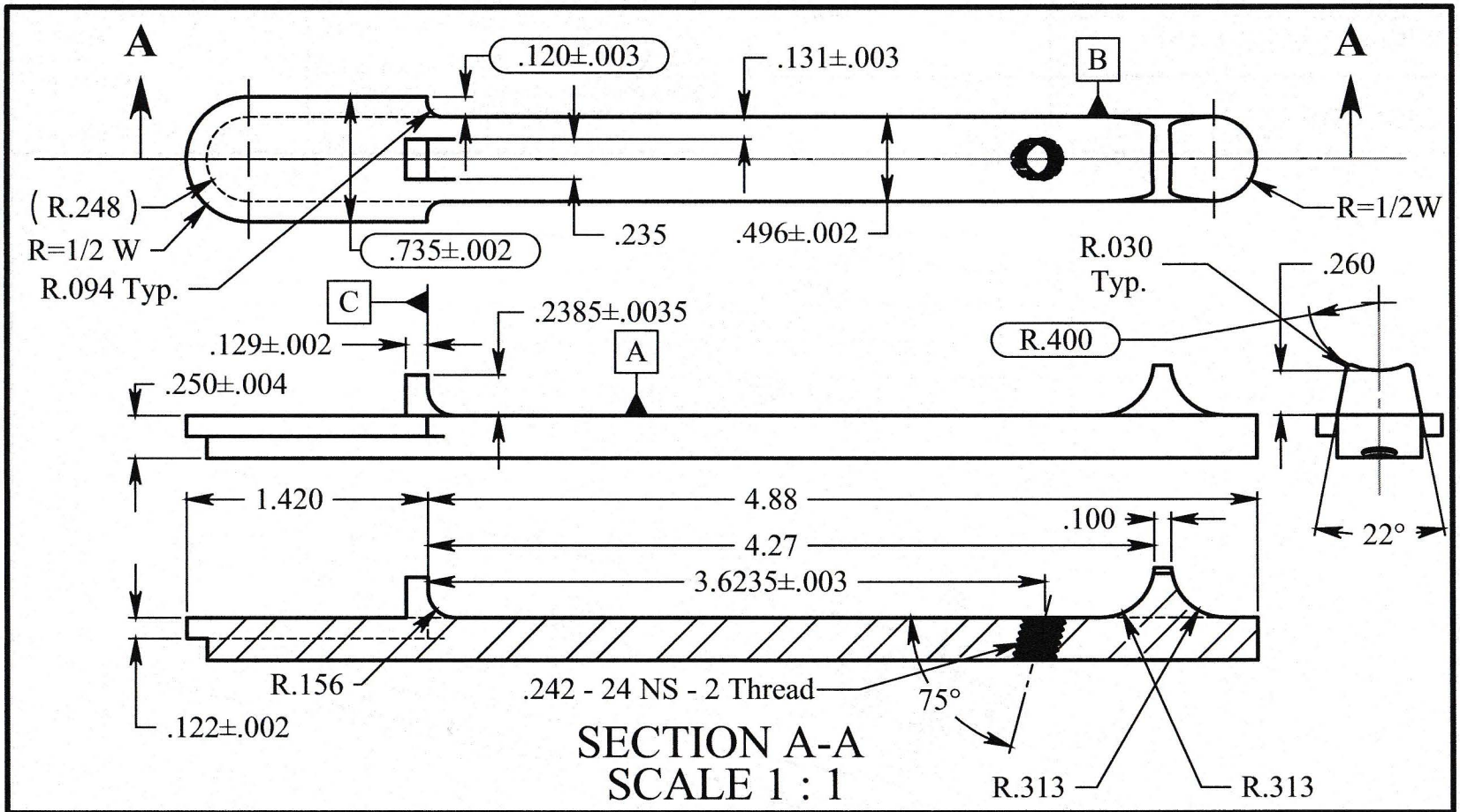
M1A1 Thompson

PART NAME
Fore End Assembly

OPERATION NAME

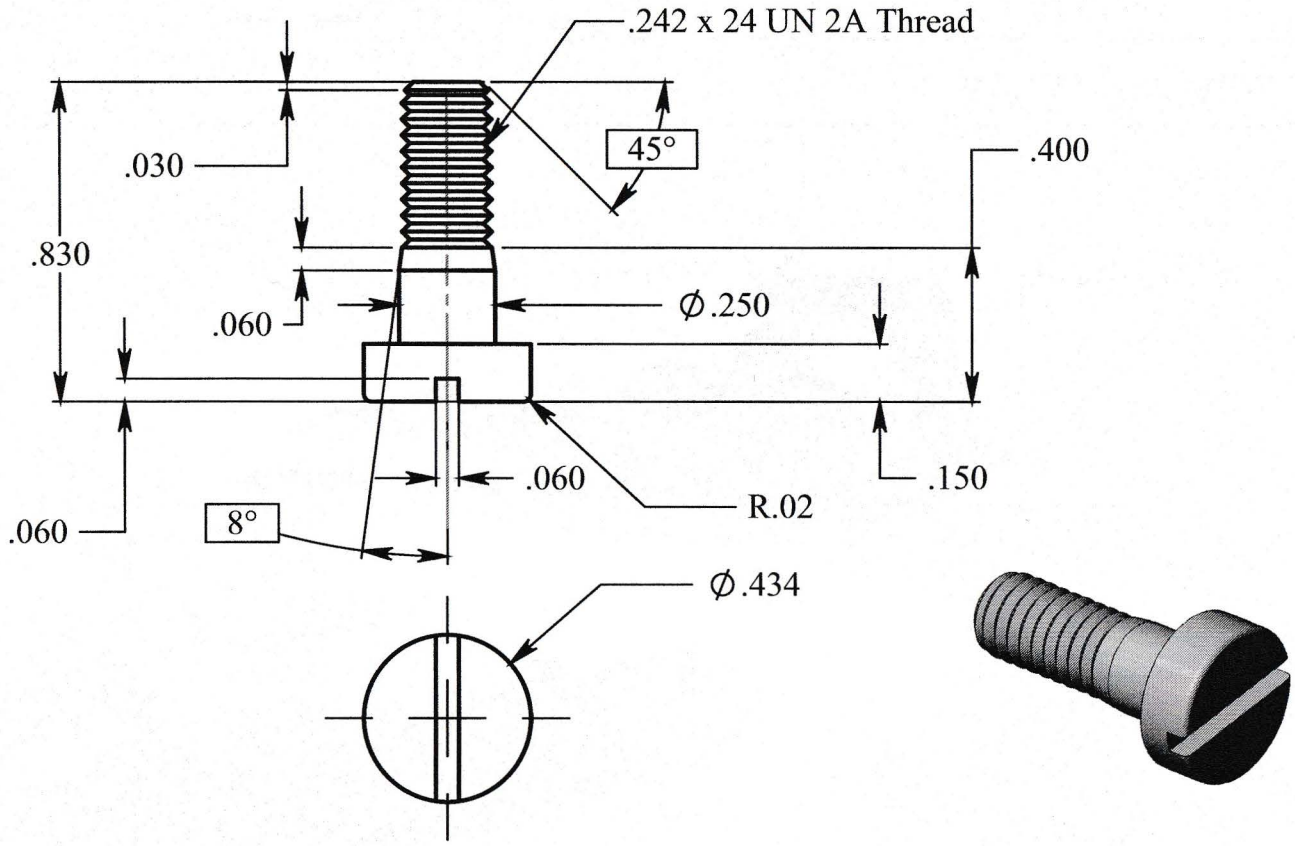
OPERATION NO.

SCALE
3:2

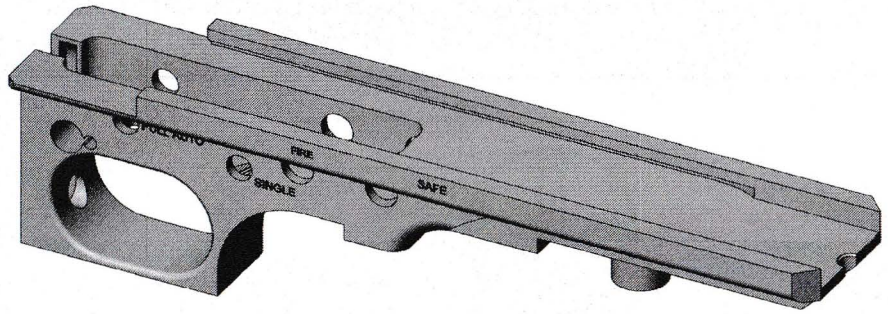


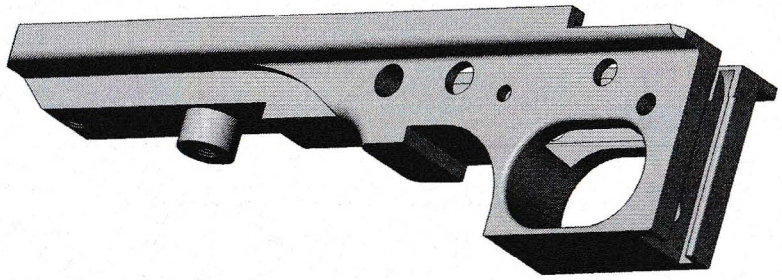
SECTION A-A
SCALE 1 : 1

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL AISI 4140 HEAT TREAT Austemper HARDNESS HRC 42 - 48 FINISH Black Oxide	M1A1 Thompson PART NAME Fore End Iron OPERATION NAME OPERATION NO. SCALE 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX Proprietary and Confidential	MATERIAL AISI 1112 HEAT TREAT Carburize HARDNESS HR15N 84 - 88 FINISH Black Oxide	M1A1 Thompson PART NAME Fore End Retaining Screw OPERATION NAME OPERATION NO. SCALE 2:1





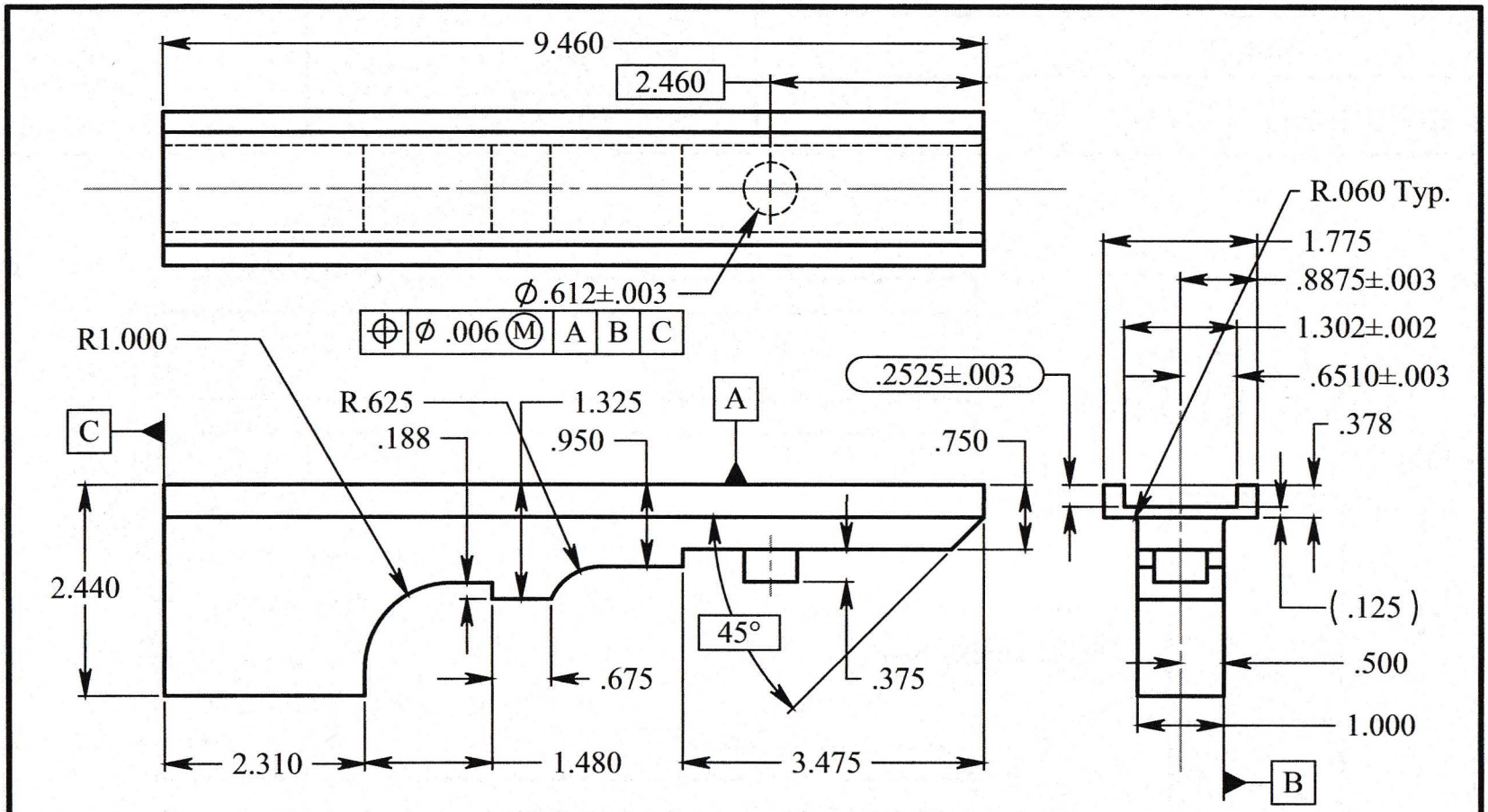
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

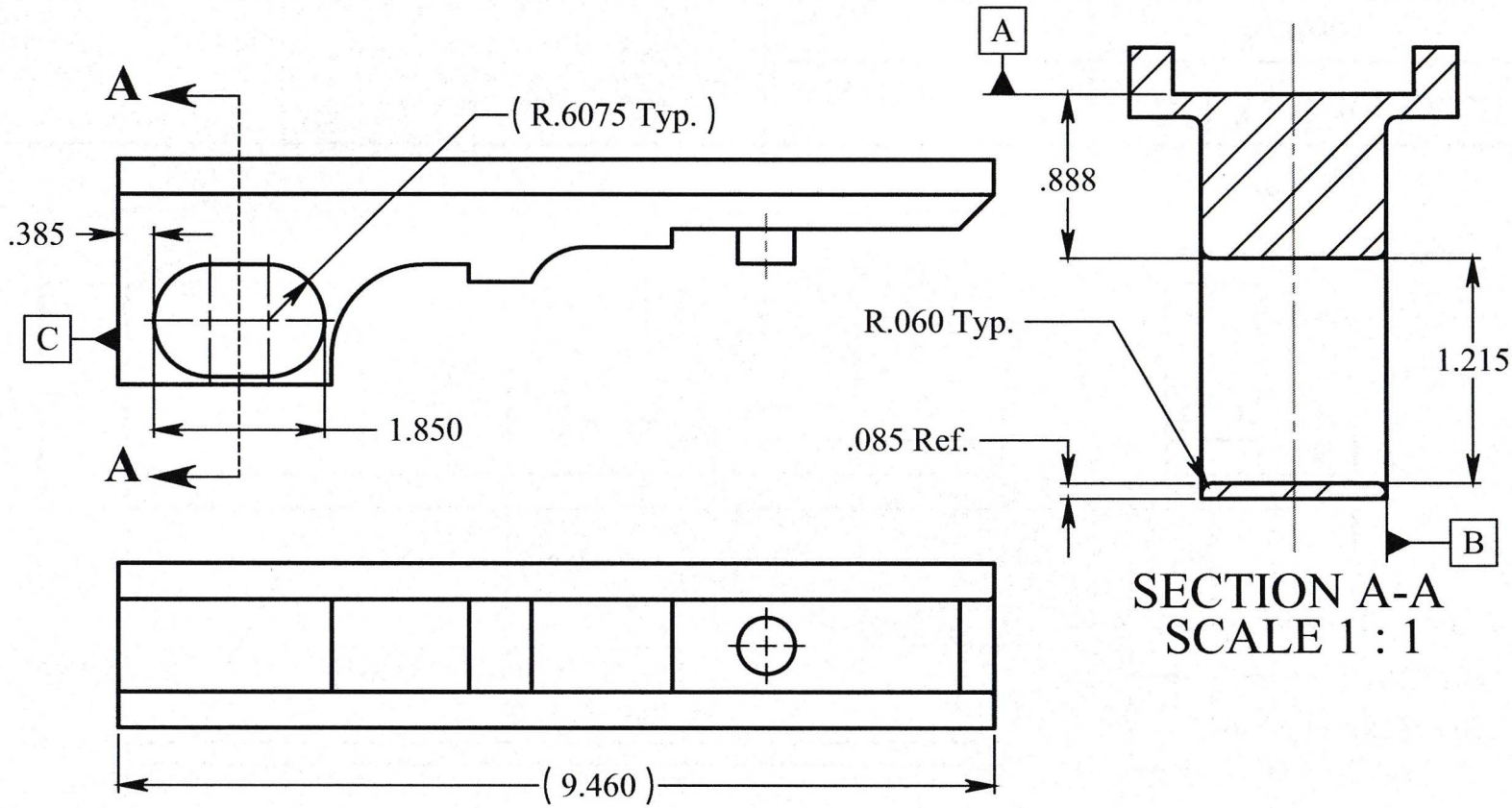
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

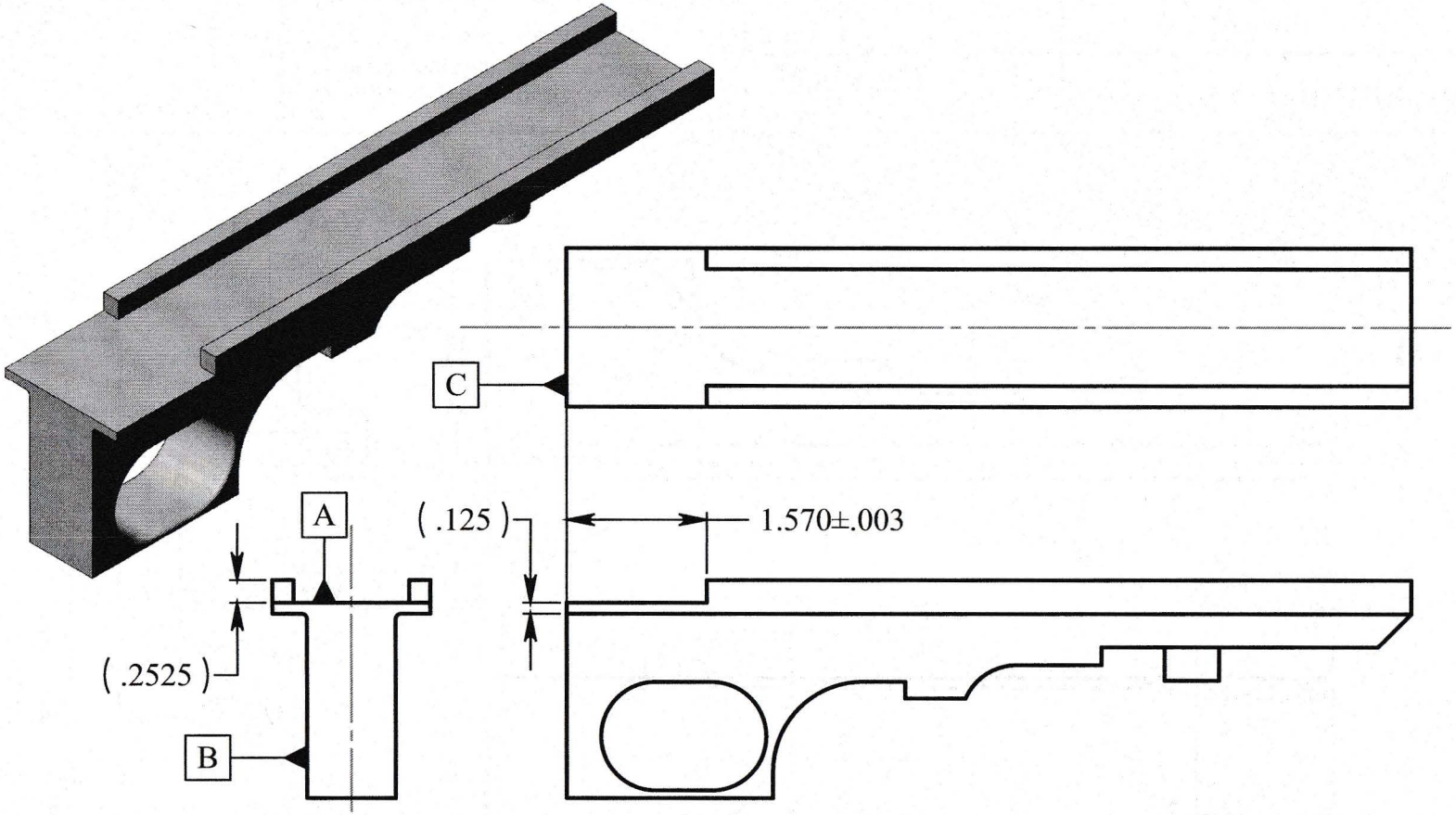
MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Frame
HARDNESS	OPERATION NAME
FINISH	OPERATION NO. / SCALE 1:2



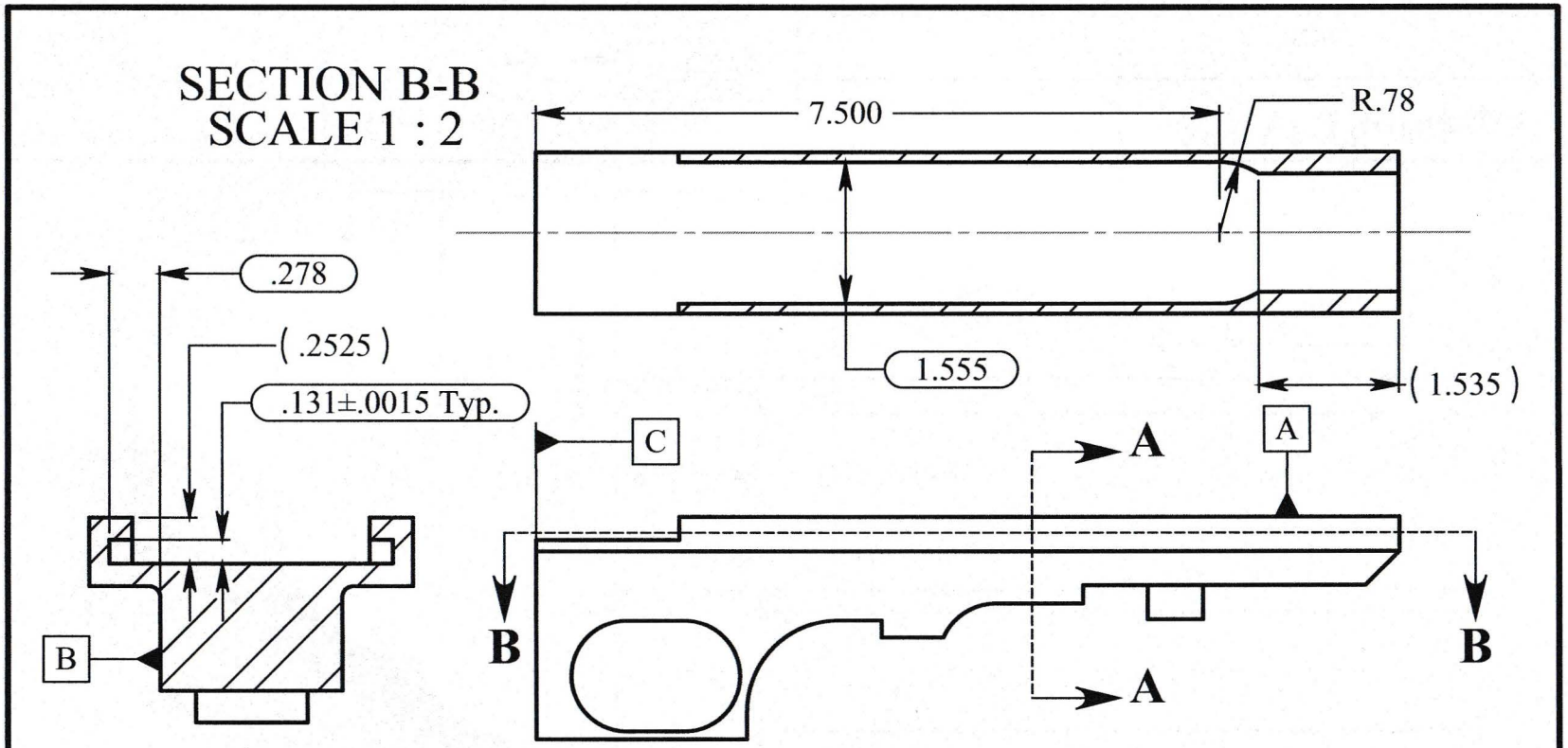
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL: AISI 1140 HEAT TREAT: None HARDNESS: HRB 100 Min. FINISH:	M1A1 Thompson PART NAME: Frame OPERATION NAME: Basic Profile OPERATION NO.: 10 SCALE: 1:2
	Proprietary and Confidential		



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL AISI 1140 HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME Frame OPERATION NAME Trigger Guard OPERATION NO. 20 SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL: AISI 1140 HEAT TREAT: HARDNESS: FINISH:	M1A1 Thompson PART NAME: Frame OPERATION NAME: Receiver Platform OPERATION NO.: 30 SCALE: 1:2



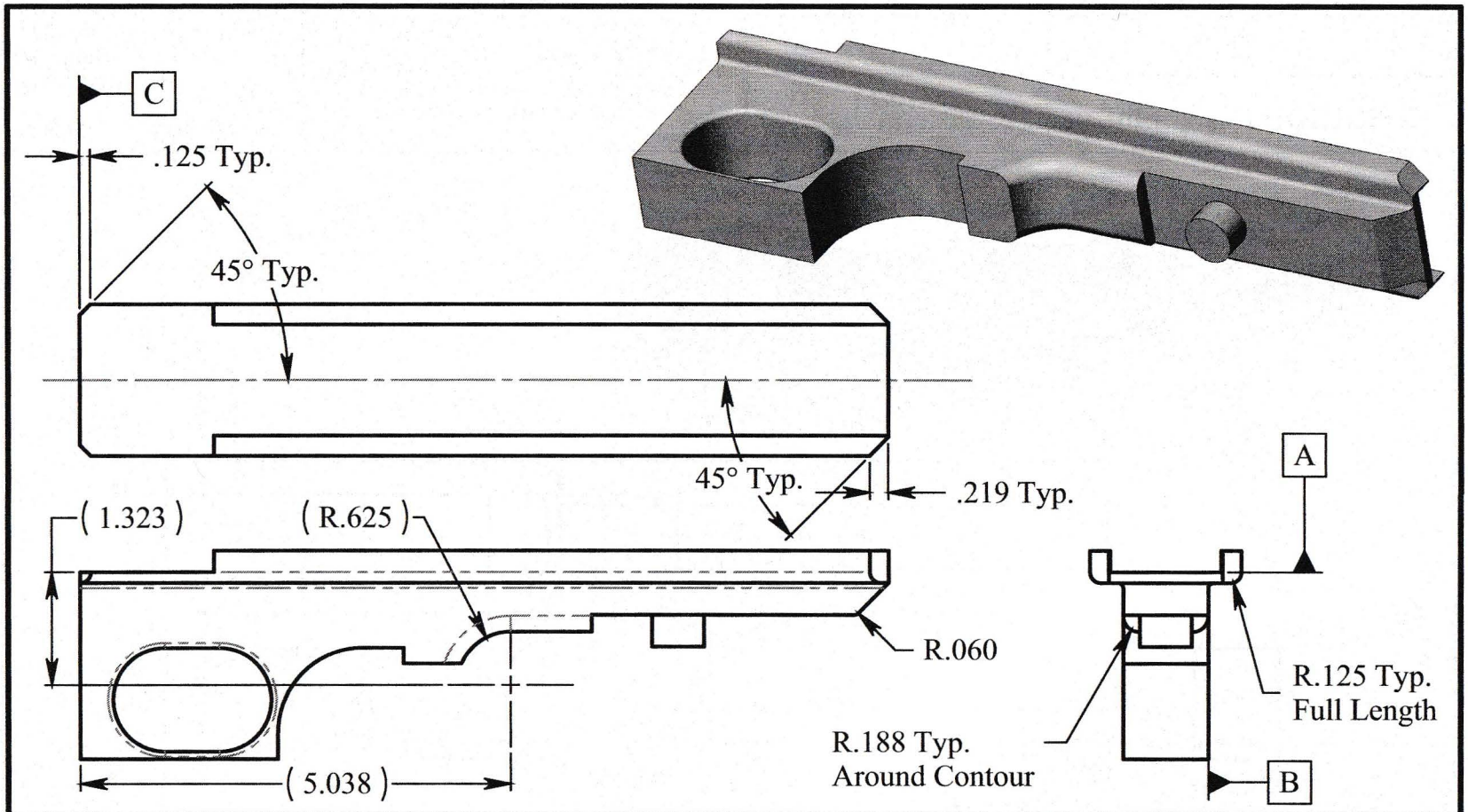
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1140	M1A1 Thompson
HEAT TREAT	PART NAME: Frame
HARDNESS	OPERATION NAME: Receiver Slot
FINISH	OPERATION NO.: 40 / SCALE: 1:2



Dimensions are in Inches

Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

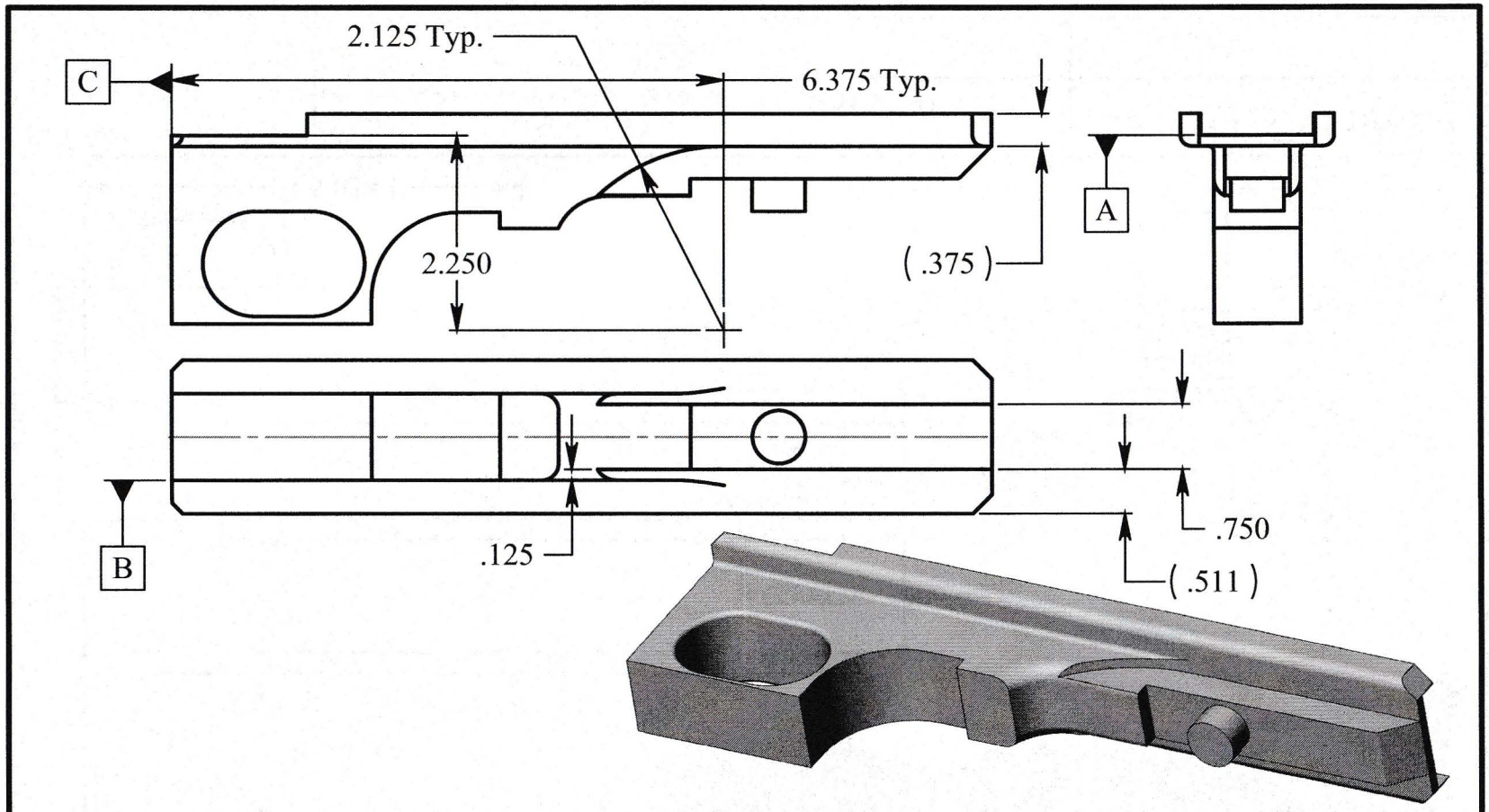
Notes:

1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX

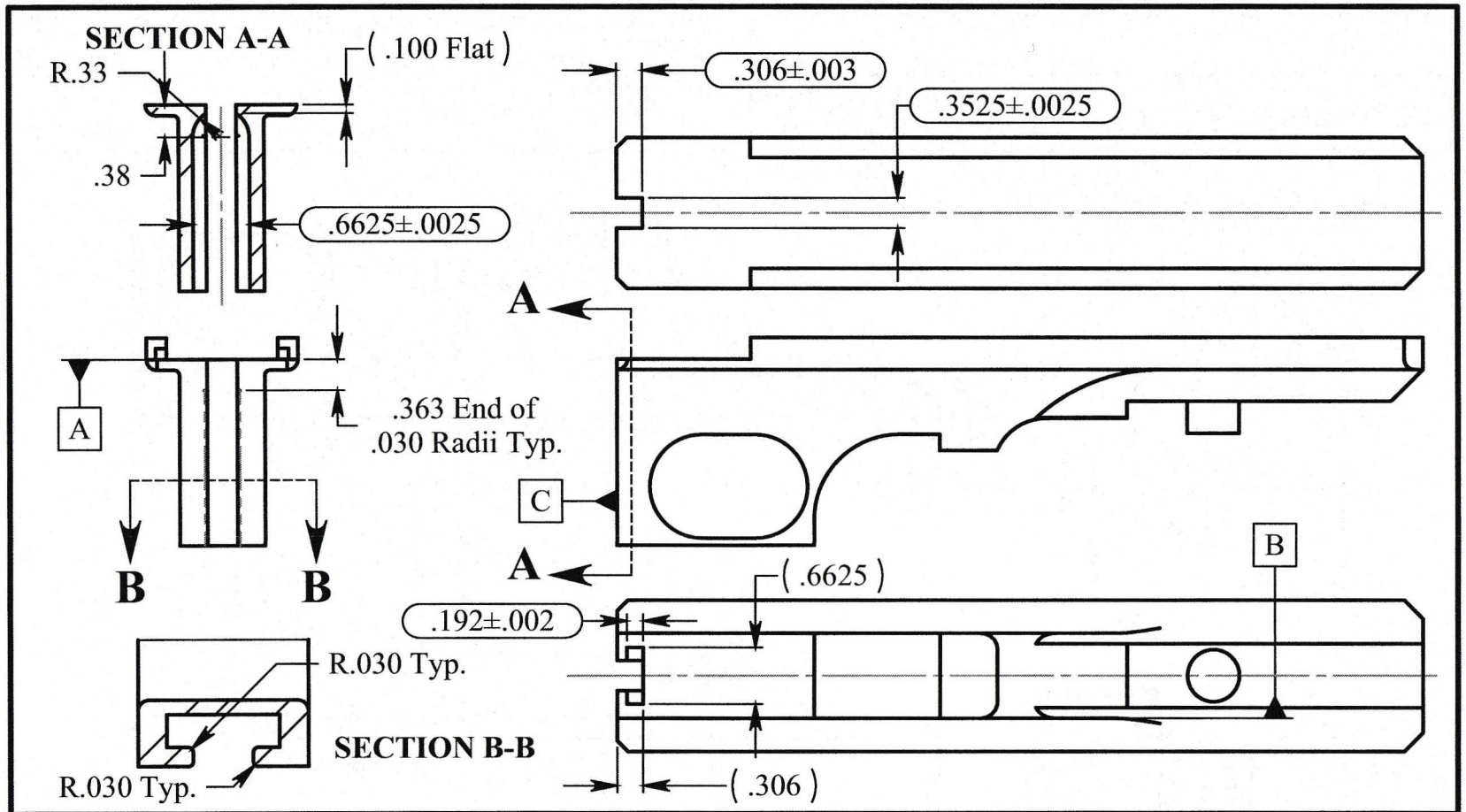
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

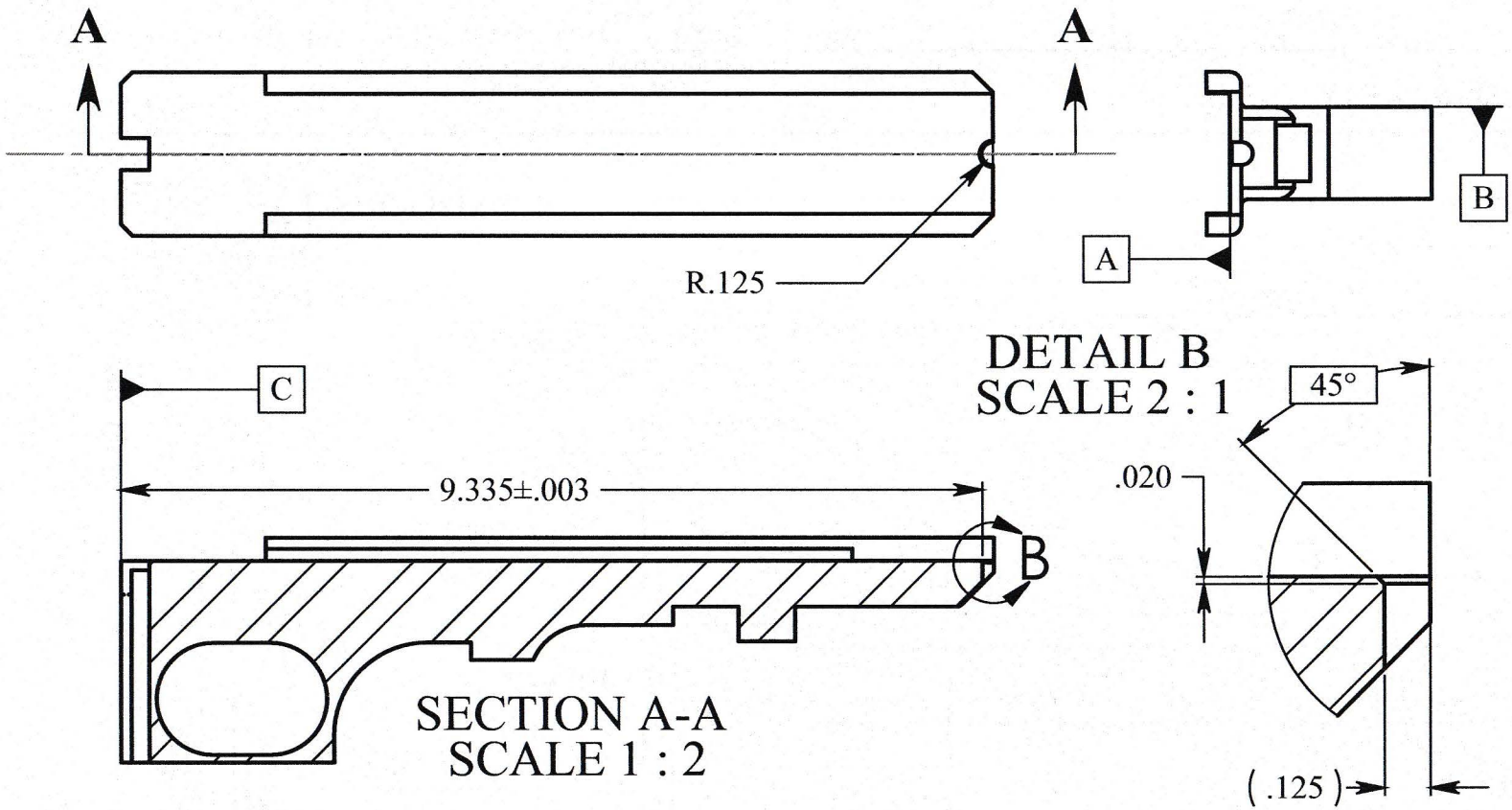
MATERIAL: AISI 1140	M1A1 Thompson
HEAT TREAT	PART NAME: Frame
HARDNESS	OPERATION NAME: Chamfers and Radii
FINISH	OPERATION NO.: 50 — SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL AISI 1140 HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME Frame OPERATION NAME Stock Clearance OPERATION NO. 60 SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX) Proprietary and Confidential	MATERIAL: AISI 1140 HEAT TREAT: HARDNESS: FINISH:	M1A1 Thompson PART NAME: Frame OPERATION NAME: Magazine Cuts OPERATION NO.: 70 SCALE: 1:2



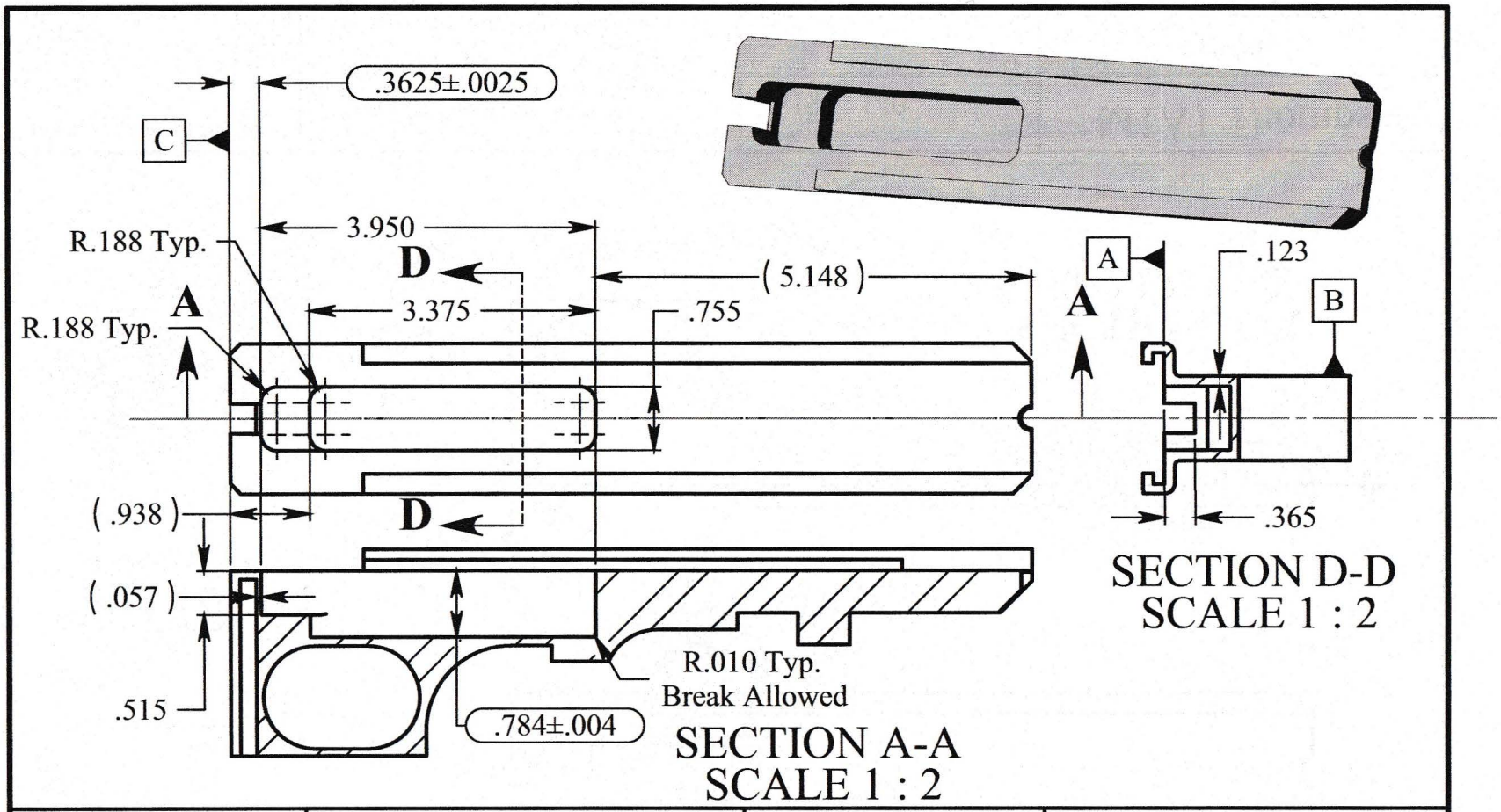
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

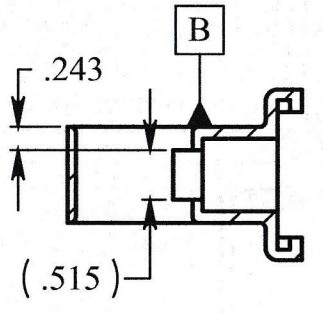
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

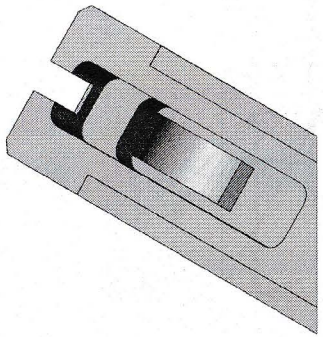
MATERIAL: AISI 1140	M1A1 Thompson
HEAT TREAT:	PART NAME: Frame
HARDNESS:	OPERATION NAME: Frame Retention Stop
FINISH:	OPERATION NO.: 80
	SCALE: 1:2

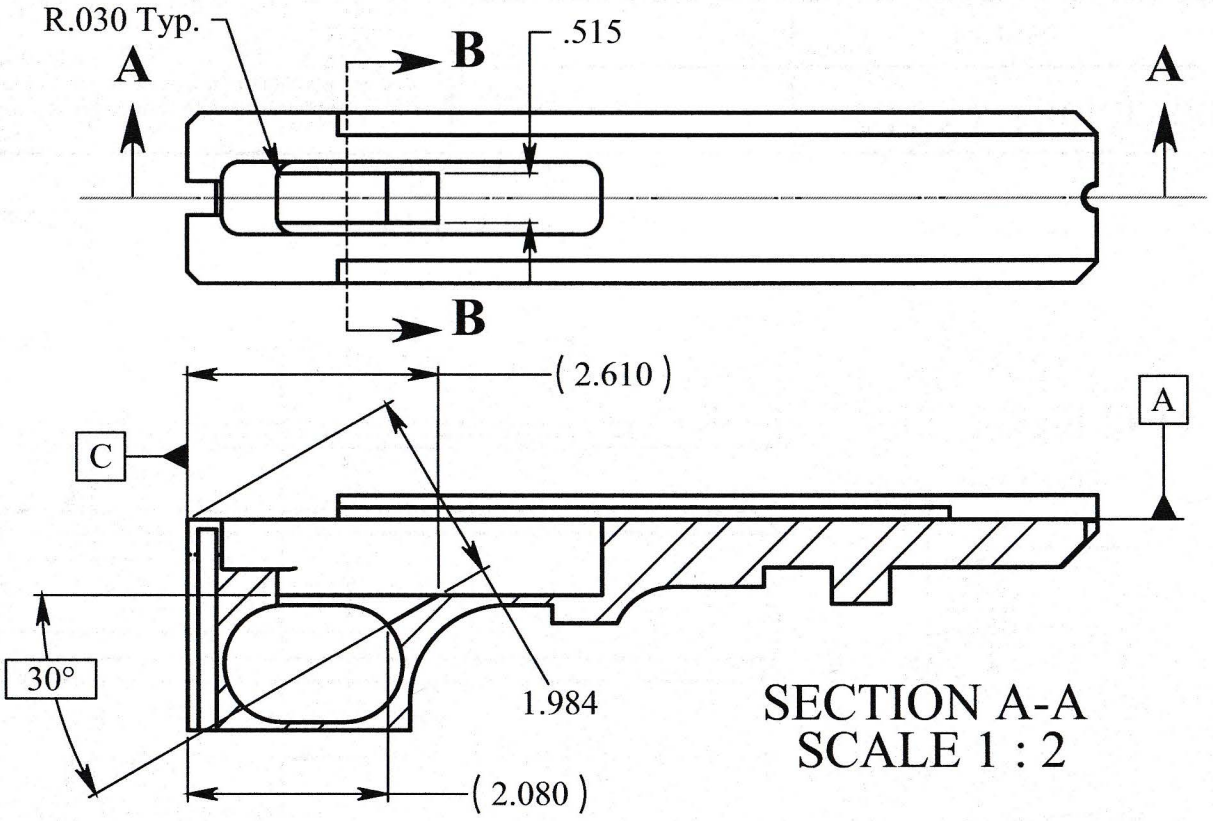


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL AISI 1140 HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME Frame OPERATION NAME Firecontrol Opening OPERATION NO. 90 SCALE 1:2



SECTION B-B
SCALE 1 : 2





SECTION A-A
SCALE 1 : 2

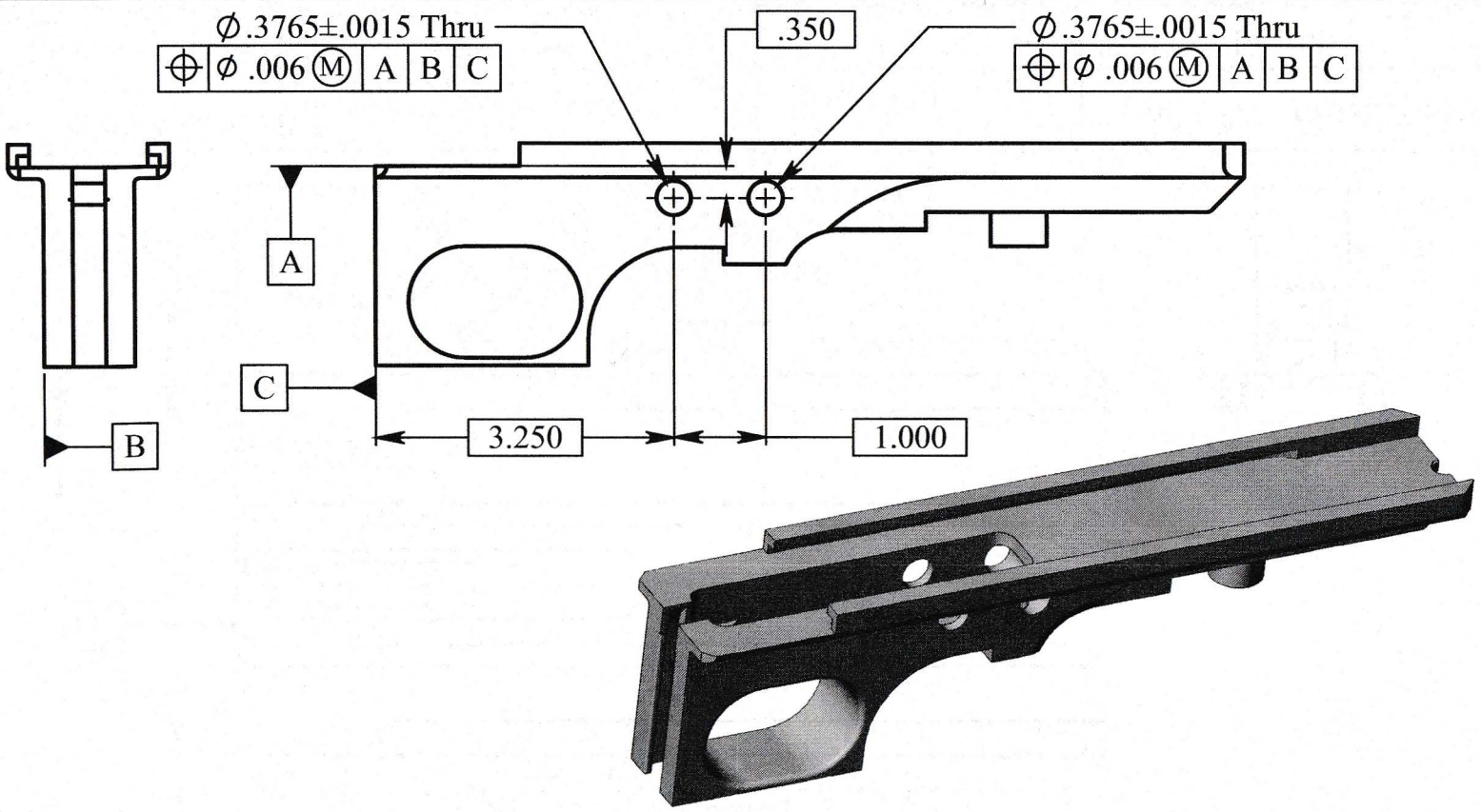
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

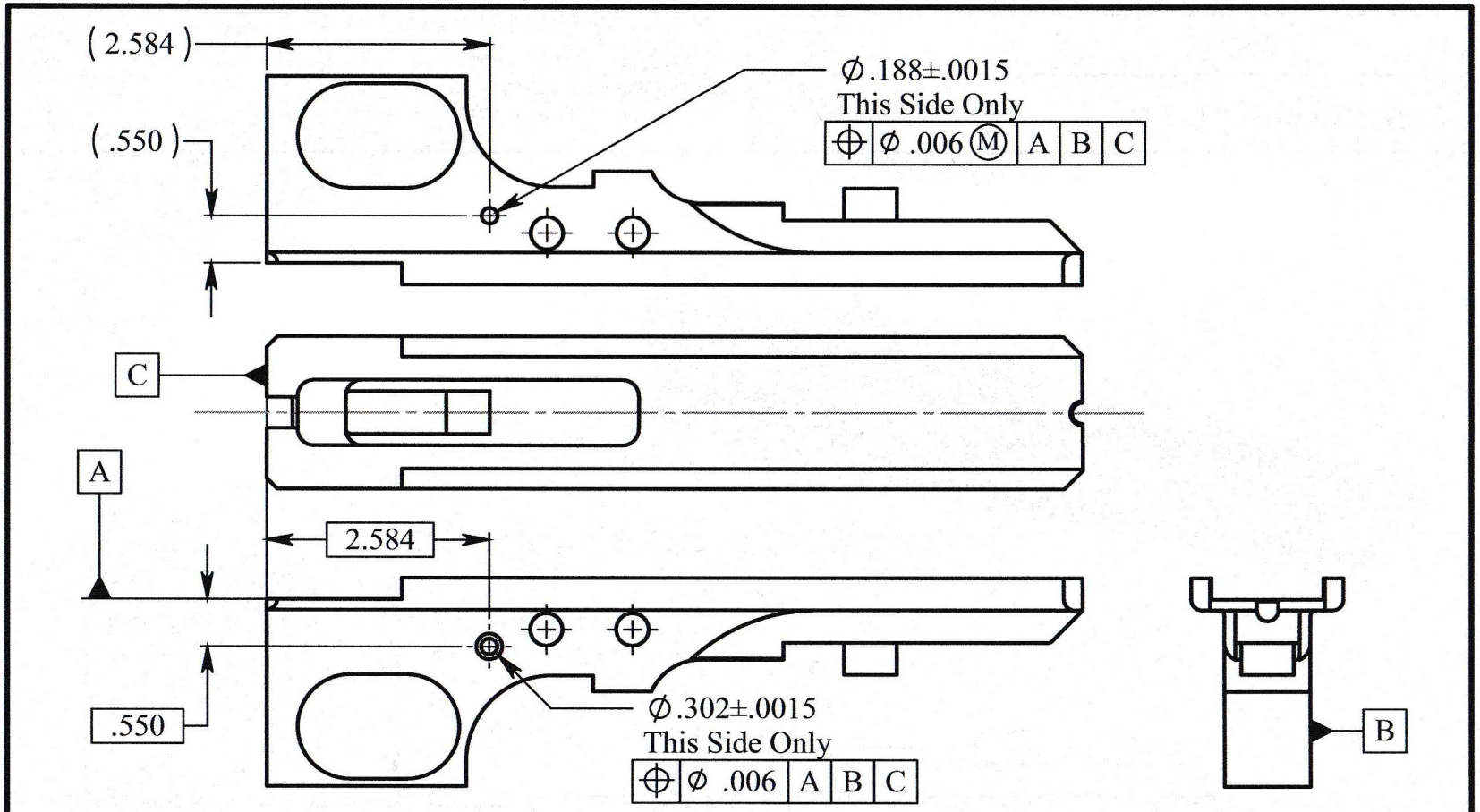
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1140	M1A1 Thompson
HEAT TREAT	PART NAME: Frame
HARDNESS	OPERATION NAME: Trigger Opening
FINISH	OPERATION NO.: 100 — SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL AISI 4140	M1A1 Thompson
		HEAT TREAT	PART NAME Frame
		HARDNESS	OPERATION NAME Pivot Holes
		FINISH	OPERATION NO. 110 / SCALE 1:2
	Proprietary and Confidential		



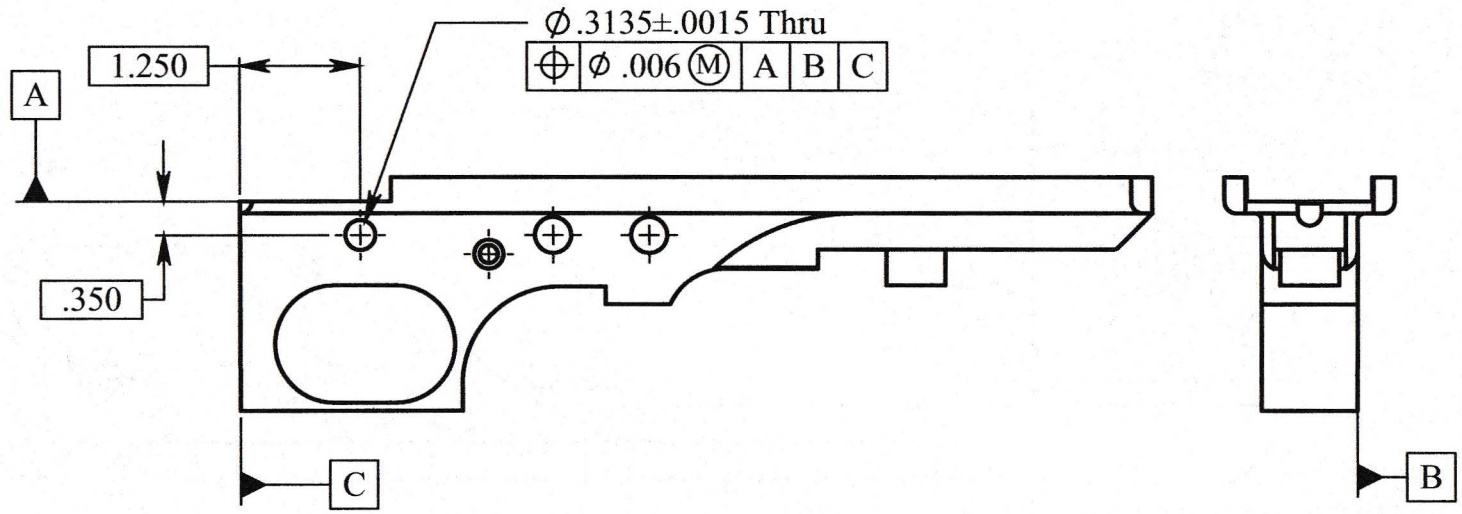
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

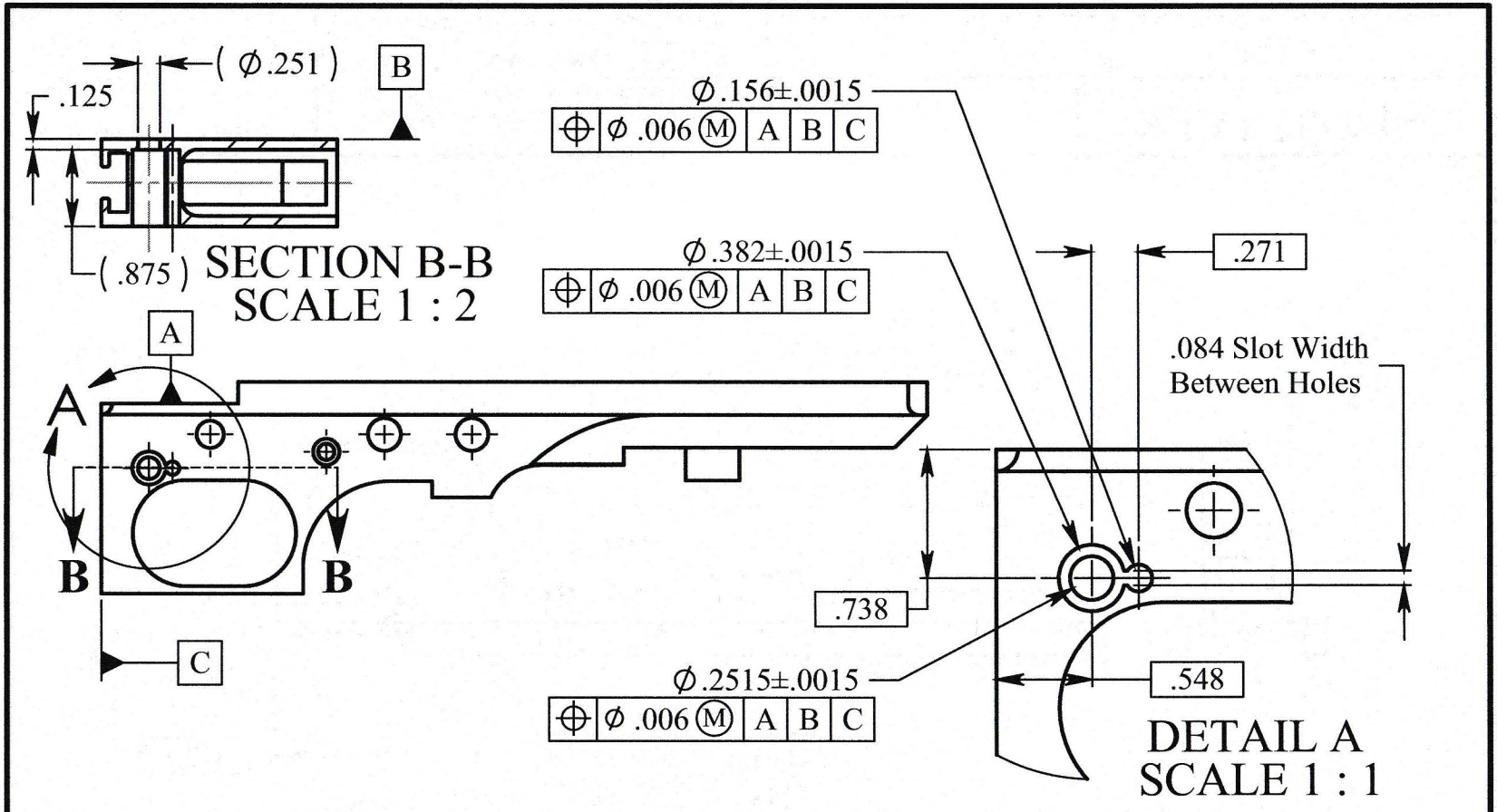
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

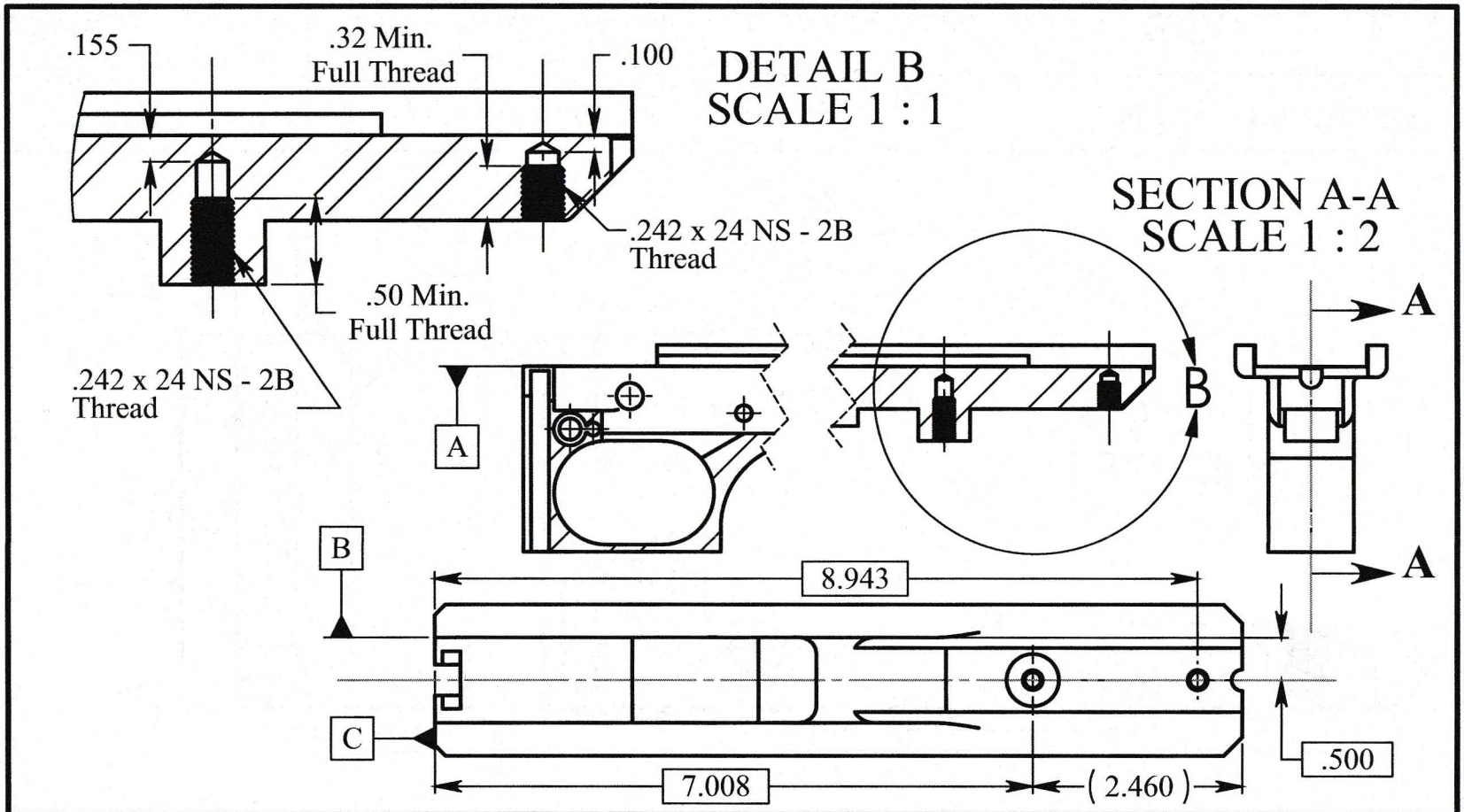
MATERIAL: AISI 1140	M1A1 Thompson
HEAT TREAT	PART NAME: Frame
HARDNESS	OPERATION NAME: Rocker Pivot
FINISH	OPERATION NO.: 120
	SCALE: 1:2



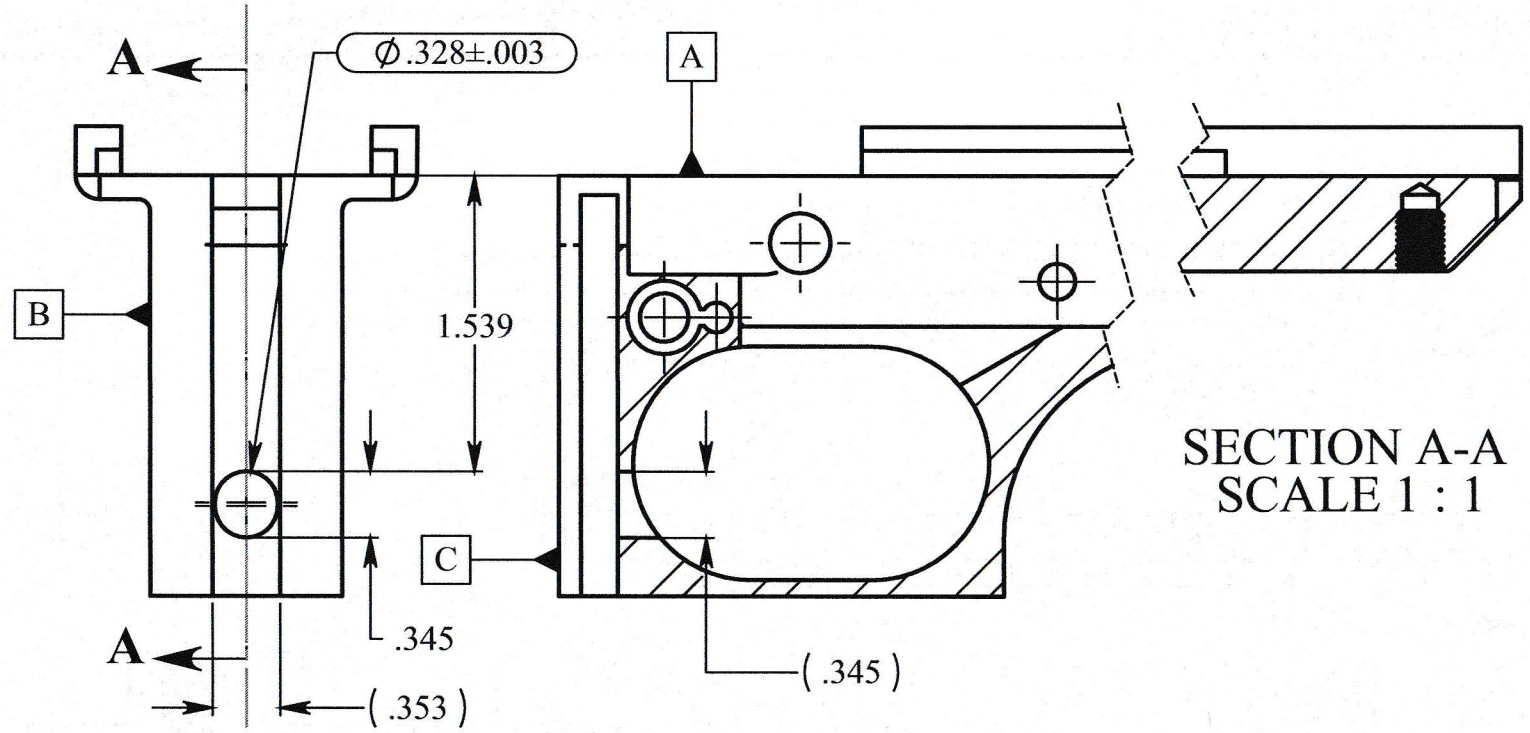
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL AISI 1140 HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME Frame OPERATION NAME Trigger Pivot OPERATION NO. 130 SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 1140	M1A1 Thompson
		HEAT TREAT	PART NAME Frame
		HARDNESS	OPERATION NAME Mag Latch Holes
		FINISH	OPERATION NO. 140 / SCALE 1:2
	Proprietary and Confidential		



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL: AISI 1140 HEAT TREAT: HARDNESS: FINISH:	M1A1 Thompson PART NAME: Frame OPERATION NAME: Threaded Holes OPERATION NO.: 150 SCALE: 1:2



SECTION A-A
SCALE 1 : 1

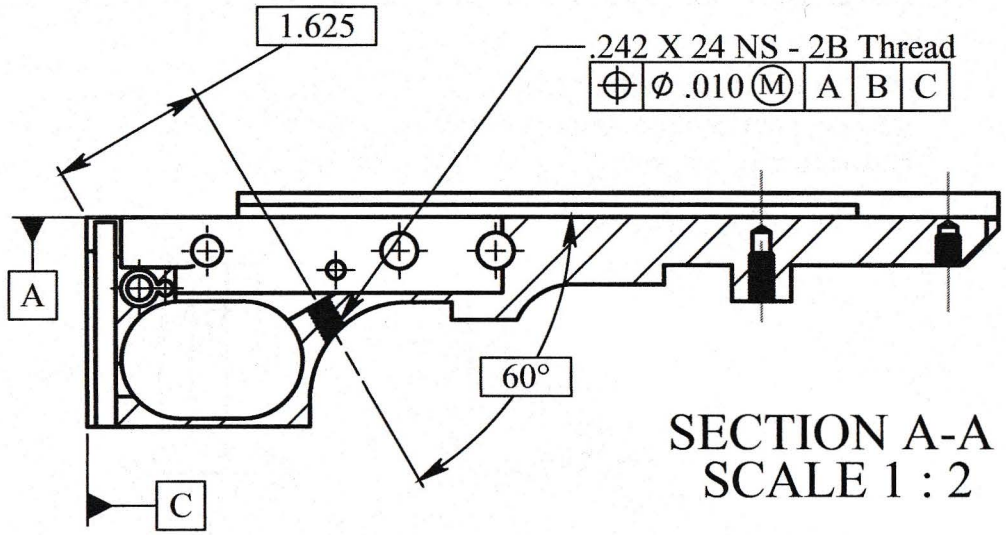
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

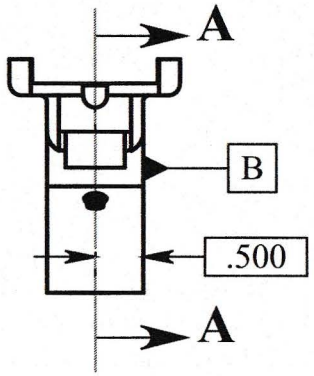
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

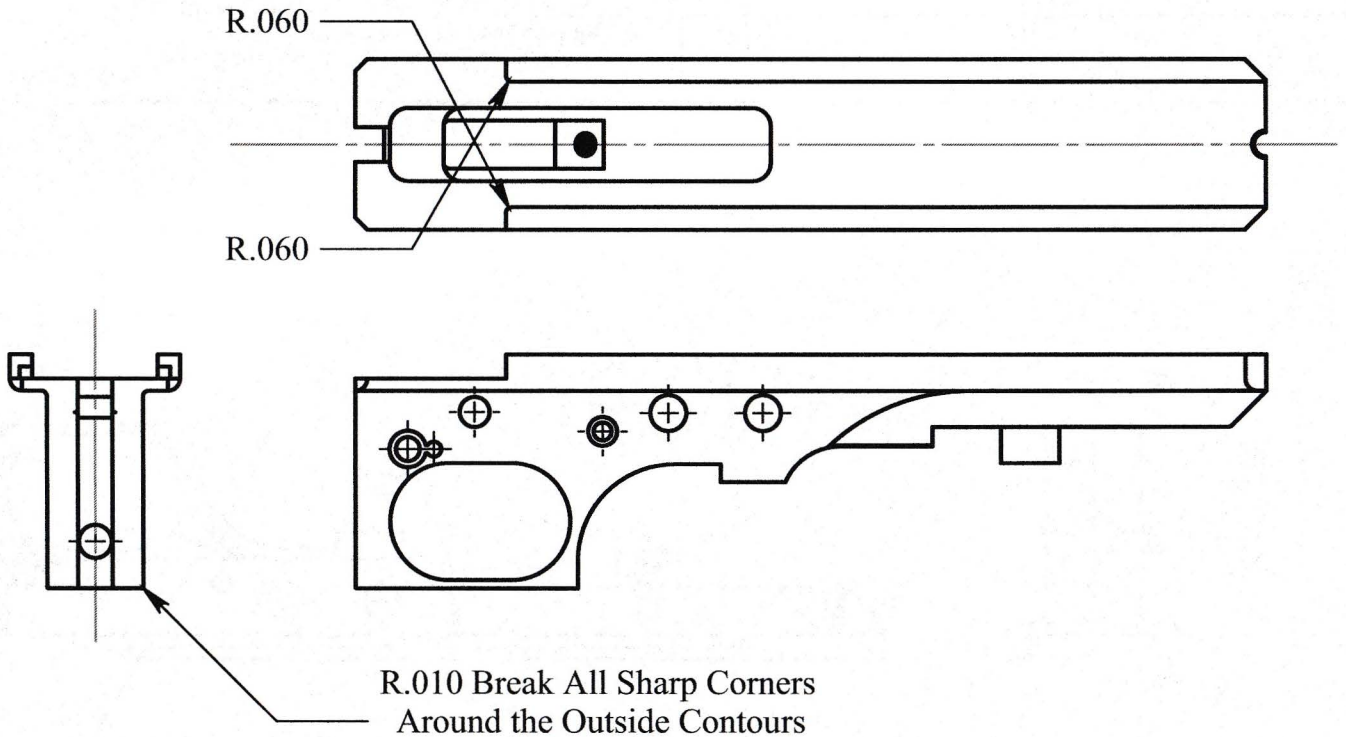
MATERIAL: AISI 1140	M1A1 Thompson
HEAT TREAT	PART NAME: Frame
HARDNESS	OPERATION NAME: Mag. Retention Hole
FINISH	OPERATION NO.: 160 — SCALE: 1:2



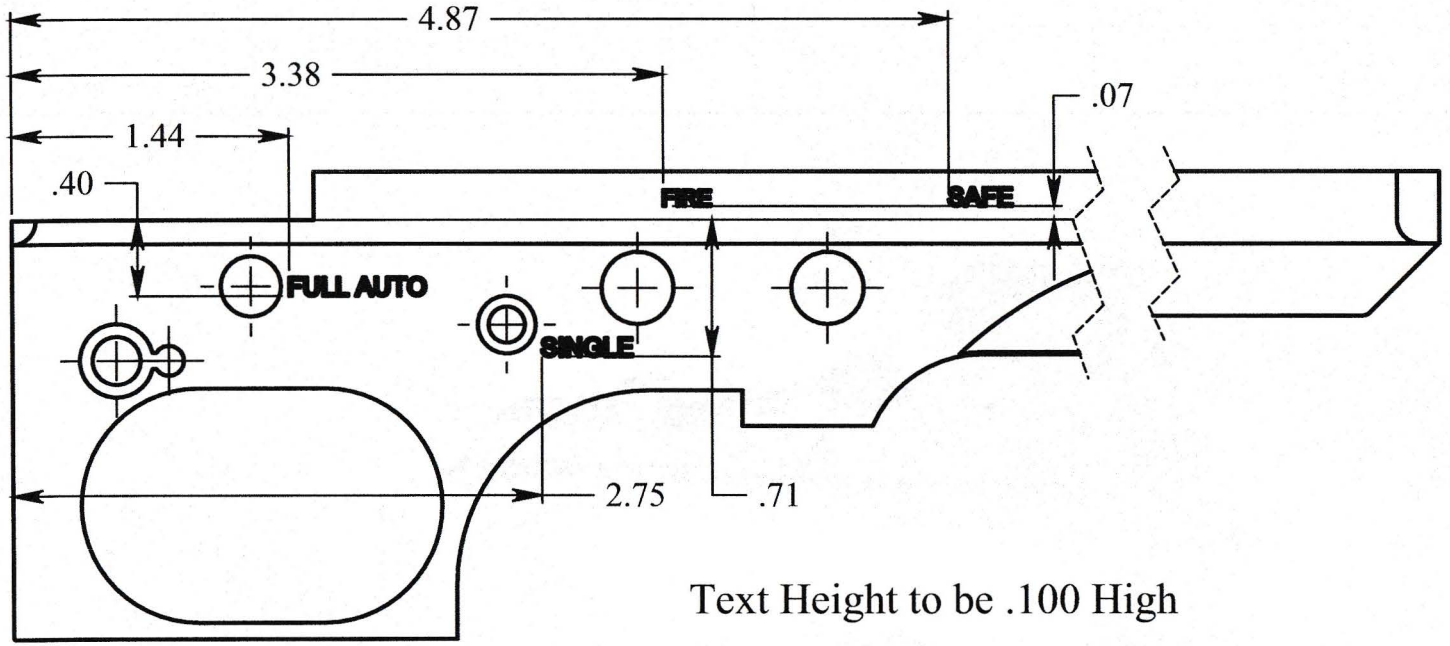
SECTION A-A
SCALE 1 : 2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL AISI 1140	M1A1 Thompson
		HEAT TREAT	PART NAME Frame
		HARDNESS	OPERATION NAME Rear Grip Hole
		FINISH	OPERATION NO. 170 / SCALE 1:2
	Proprietary and Confidential		

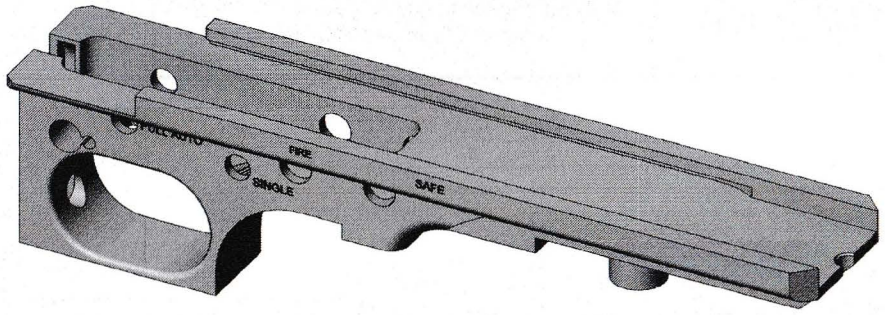


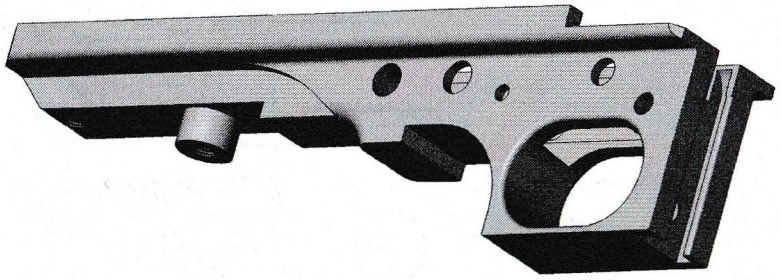
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL: AISI 1140 HEAT TREAT: HARDNESS: FINISH:	M1A1 Thompson PART NAME: Frame OPERATION NAME: Finishing Radii OPERATION NO.: 180 SCALE: 1:2



Text Height to be .100 High

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX) Proprietary and Confidential	MATERIAL AISI 1140	M1A1 Thompson	
		HEAT TREAT	PART NAME Frame	
		HARDNESS	OPERATION NAME Roll Marking	
		FINISH	OPERATION NO. 190	SCALE 1:1





Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1140 Ref.	M1A1 Thompson
HEAT TREAT: None	PART NAME: Frame
HARDNESS: HRB 100 Min.	OPERATION NAME: Finish
FINISH: Mag. Phosphate	OPERATION NO.: 200
	SCALE: 1:2

ITEM NO.	PART NUMBER	QTY.
1	Frame	1
2	Safety Lever Assy	1
	Safety	1
	Indicator Pin	1
3	Rocker Pivot Assy	1
	Rocker Pivot	1
	Indicator Pin	1
4	Rocker	1
5	Sear Lever	1
6	Sear	1
7	Rear Grip	1
8	Rear Grip Retaining Screw	1
9	Trip	1
10	Trigger	1
11	Disconnector	1
12	Pivot Plate Assembly	1
	Pivot Plate	1
	Pivot Plate Pin Front	1
	Pivot Plate Pin Rear	1
13	Sear Spring	1
14	Trigger Return Spring	1
15	Disconnector Spring	1
16	Sear Lever Retaining Spring	1
17	Magazine Latch Assembly	1
	Magazine Latch	1
	Mag. Latch Pivot	1
18	Magazine Latch Spring	1

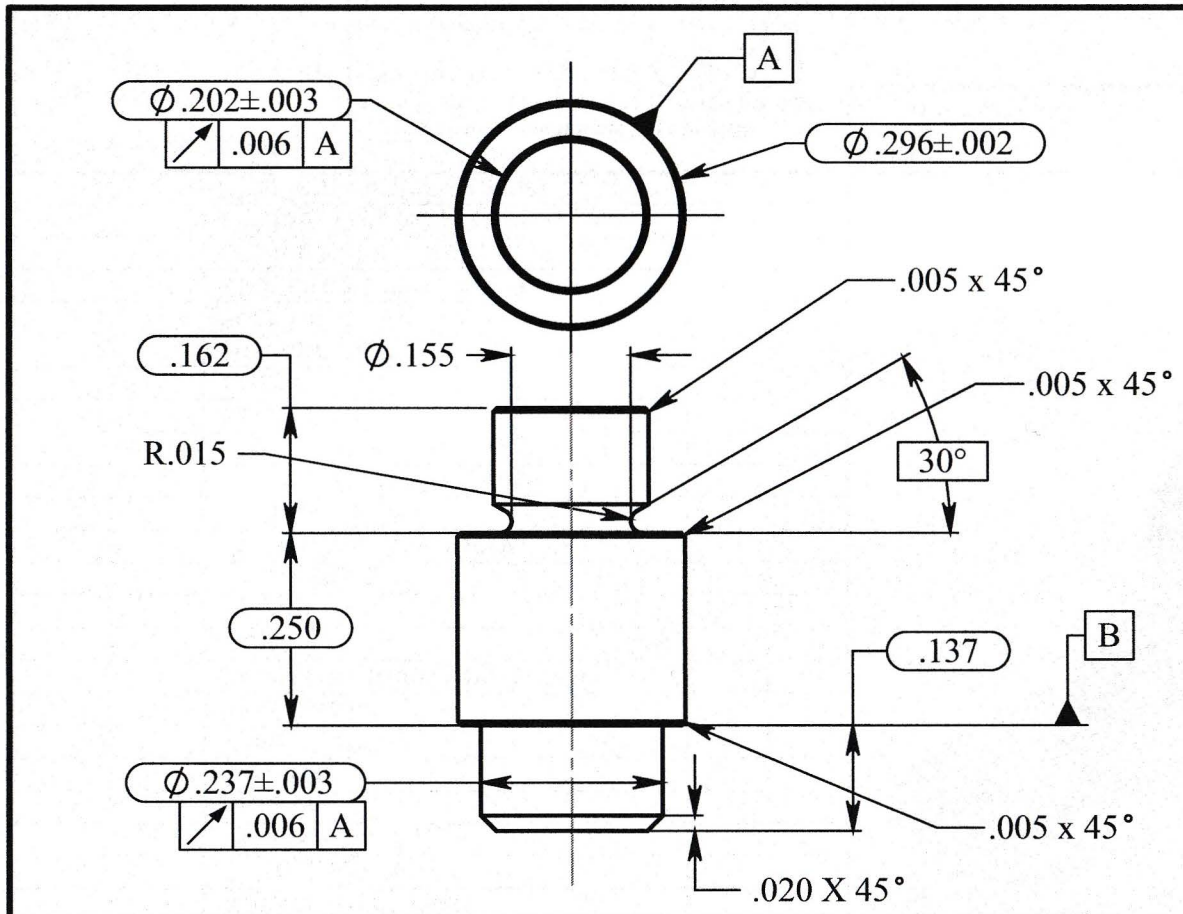
Dimensions are in Inches

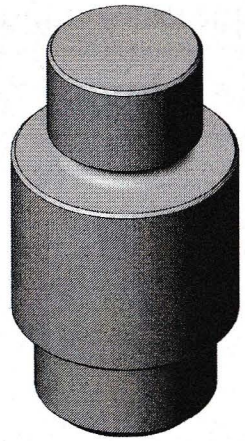
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME Frame Assembly
HARDNESS	OPERATION NAME
FINISH	OPERATION NO. / SCALE 1:2





Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1215	M1A1 Thompson
HEAT TREAT: Carburize .010 Min. Case	PART NAME: Frame Latch
HARDNESS: HR15N 88 - 92	OPERATION NAME:
FINISH: Black Oxide	OPERATION NO.: / SCALE: 4:1

Manufacturing Data:

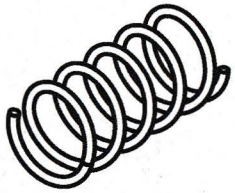
Spring Type:	Helical Compression
Outside Diameter:	.275 inches
Wire Diameter:	.026
Total Coils:	5.5
Active Coils:	3.5
Coil Type:	Closed, Not Ground
Free Length:	.525
Wind Direction:	Either Hand

Inspection Data:

Load Length L1:	.320 inches
Load P1:	2.5 +/-.5 lbs.
Load Length L2:	.195 inches
Loap P2:	4.0 lbs +/-.5 lbs.
Max. Solid Height:	.180 inches
Spring works in a:	.300 diameter hole
Spring works over:	.199 diameter rod

Engineering Data:

Spring Rate:	12.0 lbs/in.
Spring Index:	9.6
Static Solid Stress:	177,300 psi
Stress Percentage: at Solid Height	52.4 %



Expand the last end coil on one end to an outside diameter of .325 +/-.005
Reduce the last coil of the other end to an outside diameter of .235 +/-.005

Dimensions are in Inches

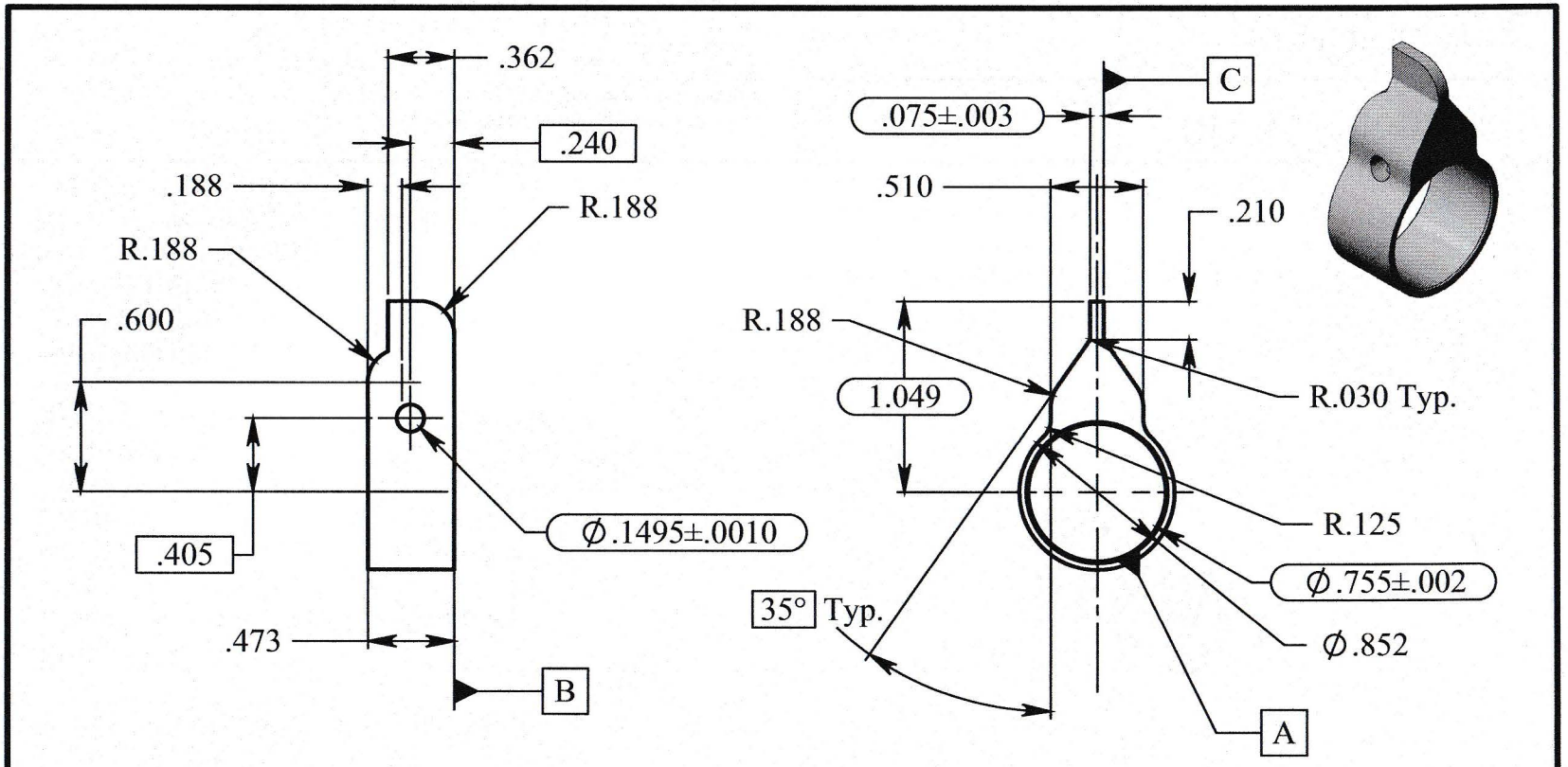
Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)

Proprietary and Confidential

MATERIAL: Music Wire ASTM - A228	M1A1 Thompson	
HEAT TREAT: Stress Relieve	PART NAME: Frame Latch Spring	
HARDNESS	OPERATION NAME	
FINISH	OPERATION NO.	SCALE: 1:2



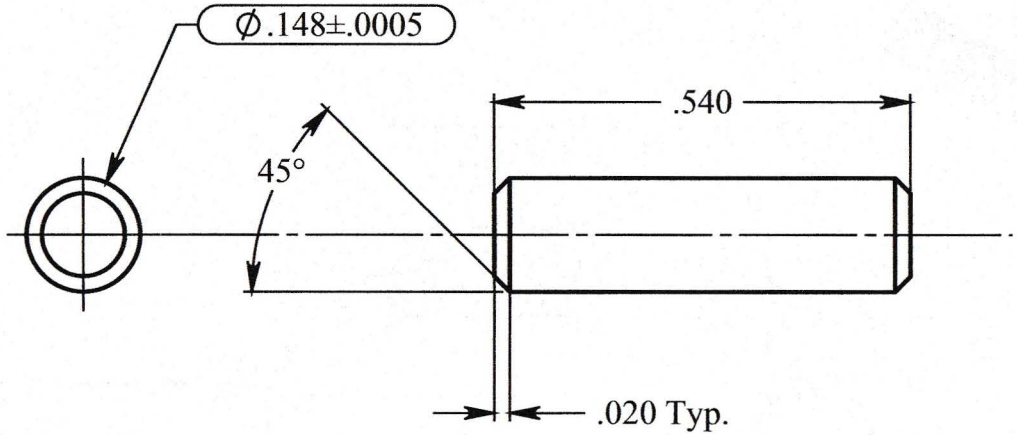
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

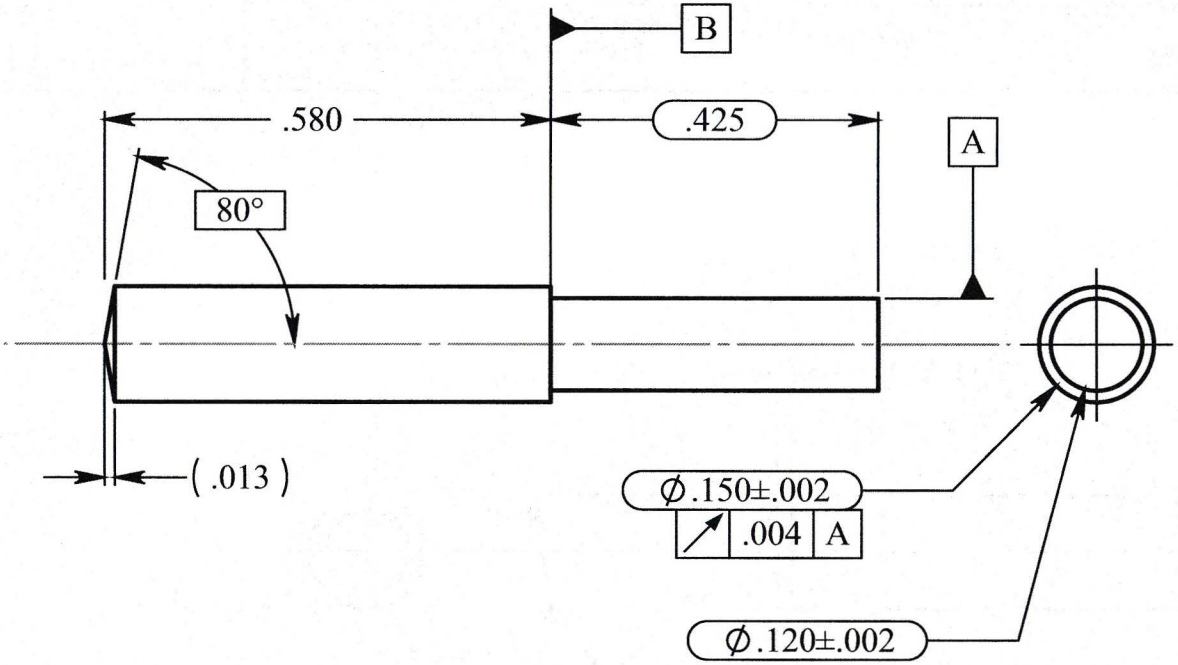
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

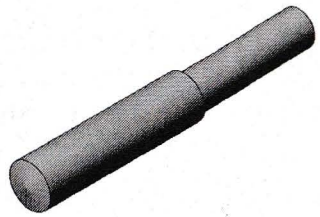
Proprietary and Confidential

MATERIAL: AISI 1140	M1A1 Thompson
HEAT TREAT: None	PART NAME: Front Sight
HARDNESS: HRB 100 MIN.	OPERATION NAME:
FINISH: Mag. Phosphate	OPERATION NO.: / SCALE: 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX	MATERIAL AISI 1095	M1A1 Thompson	
		HEAT TREAT Neutral Salt Harden	PART NAME Front Sight Retaining Pin	
		HARDNESS HRC 48 - 53	OPERATION NAME	
		FINISH Black Oxide	OPERATION NO.	SCALE 4:1
	Proprietary and Confidential			





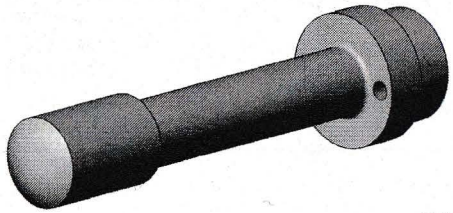
Dimensions are in Inches

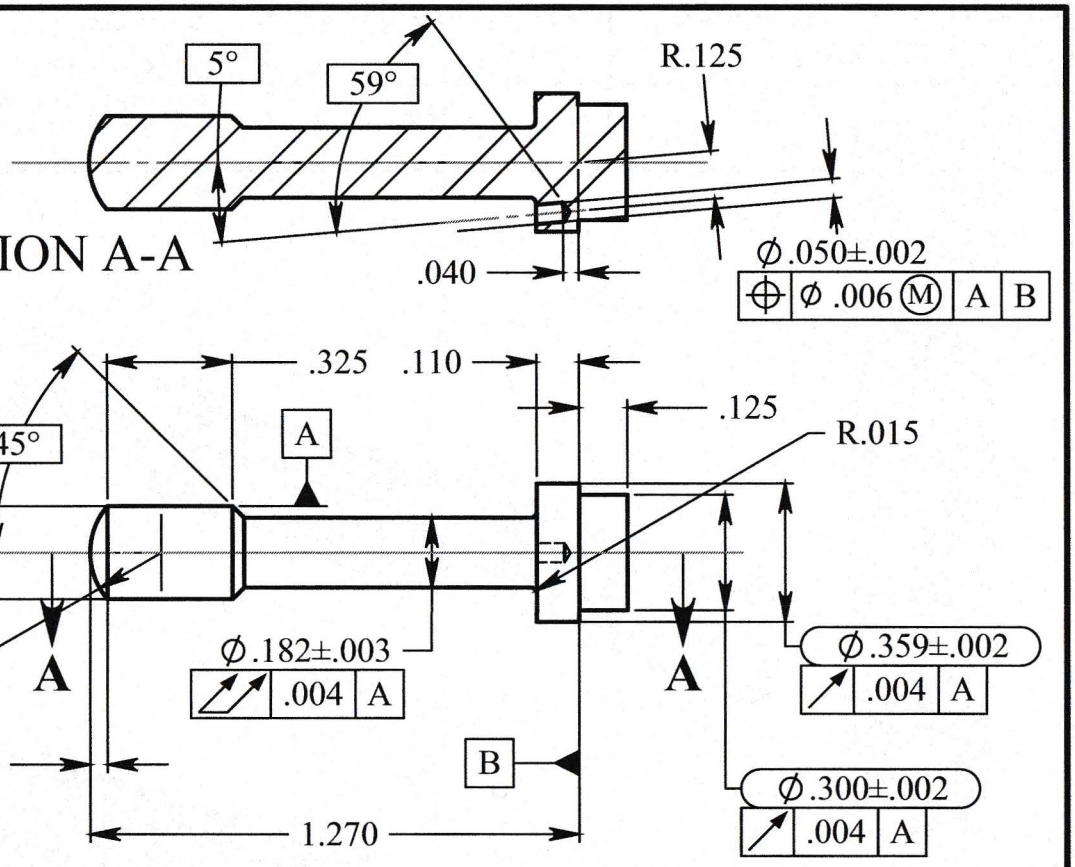
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

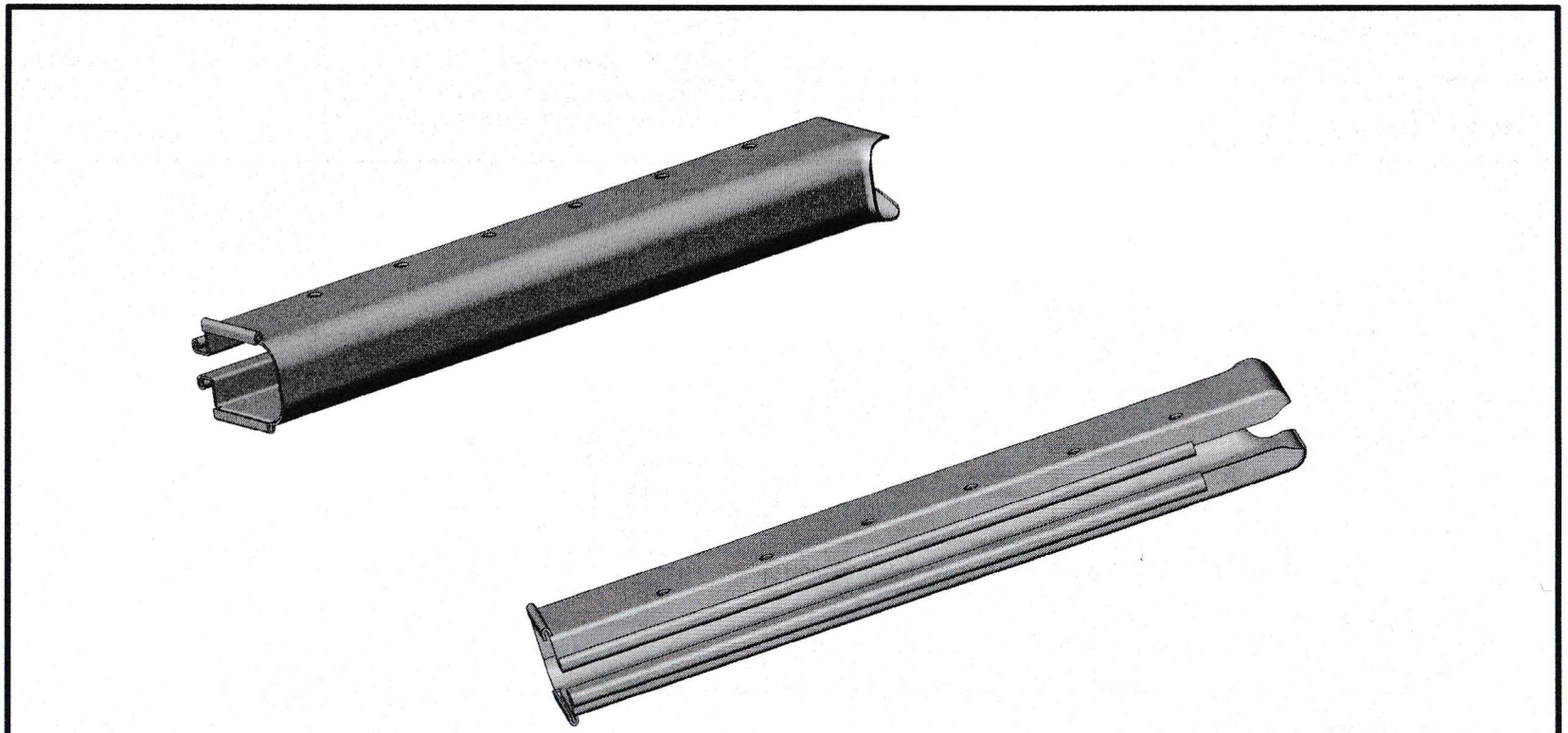
Proprietary and Confidential

MATERIAL: AISI 1095	M1A1 Thompson
HEAT TREAT: None	PART NAME: Indicator Pin
HARDNESS: HRB 100 Min.	OPERATION NAME:
FINISH: None	OPERATION NO.: SCALE: 4:1

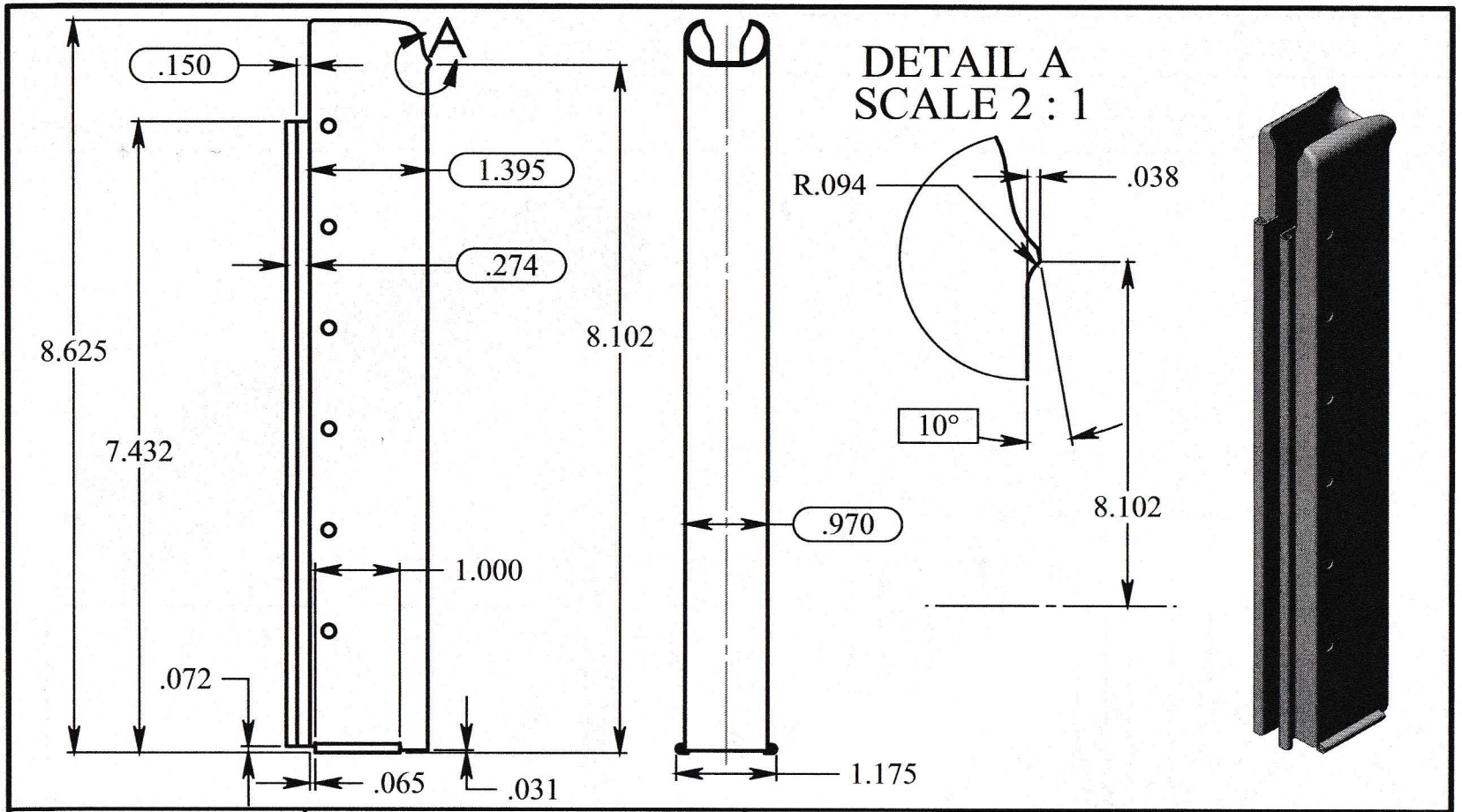




Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 1095	M1A1 Thompson
		HEAT TREAT	PART NAME Magazine Latch Pivot
		HARDNESS	OPERATION NAME
		FINISH	OPERATION NO. / SCALE 2:1
	Proprietary and Confidential		

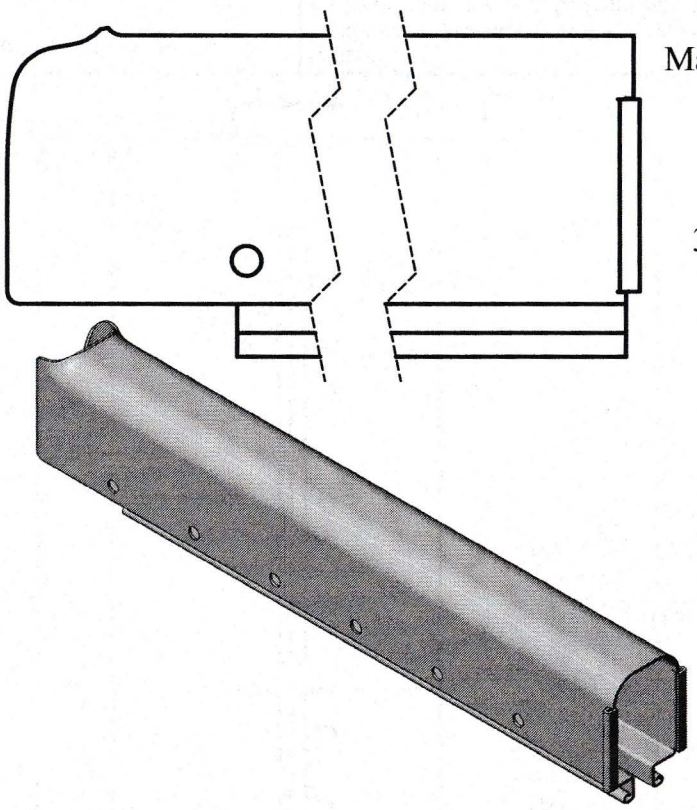


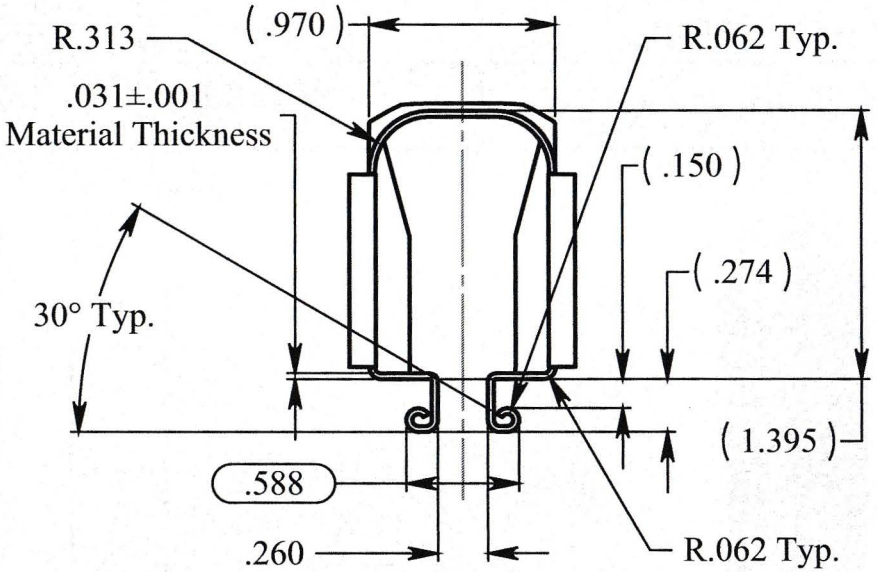
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)	MATERIAL AISI 1020	M1A1 Thompson
		HEAT TREAT	PART NAME Magazine Box
		HARDNESS	OPERATION NAME
	Proprietary and Confidential	FINISH	OPERATION NO. / SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL: AISI 1020 HEAT TREAT: HARDNESS: FINISH:	M1A1 Thompson PART NAME: Magazine Box OPERATION NAME: Side Profile OPERATION NO.: 10 SCALE: 1:2

Proprietary and Confidential





Dimensions are in Inches

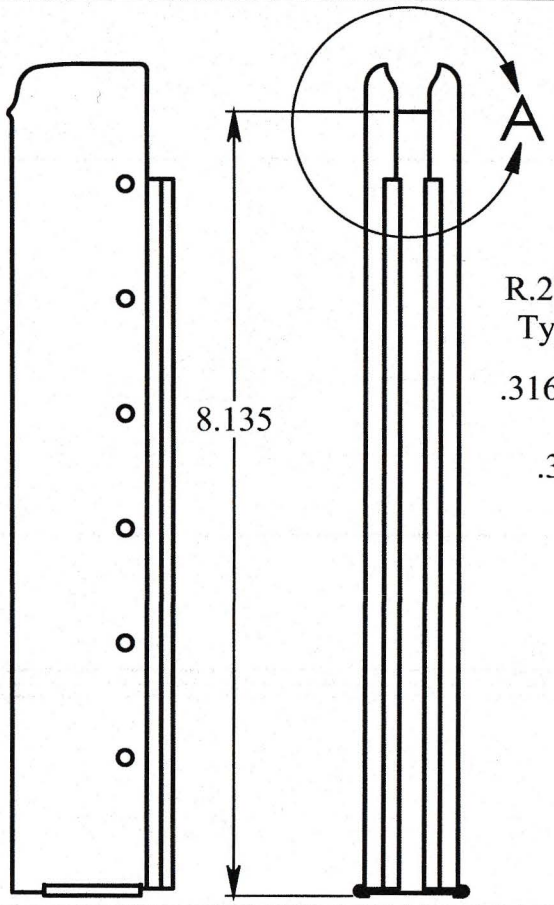
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

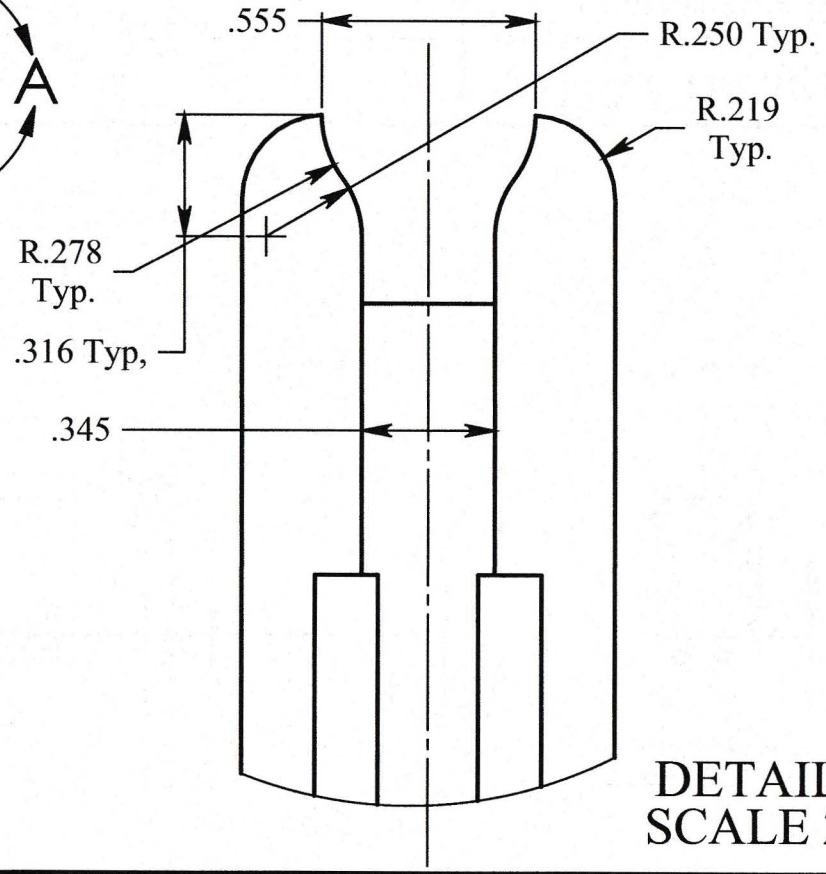
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX

2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME Magazine Box
HARDNESS	OPERATION NAME Bottom Profile
FINISH	OPERATION NO. 20 / SCALE 1:2





DETAIL A
SCALE 2 : 1

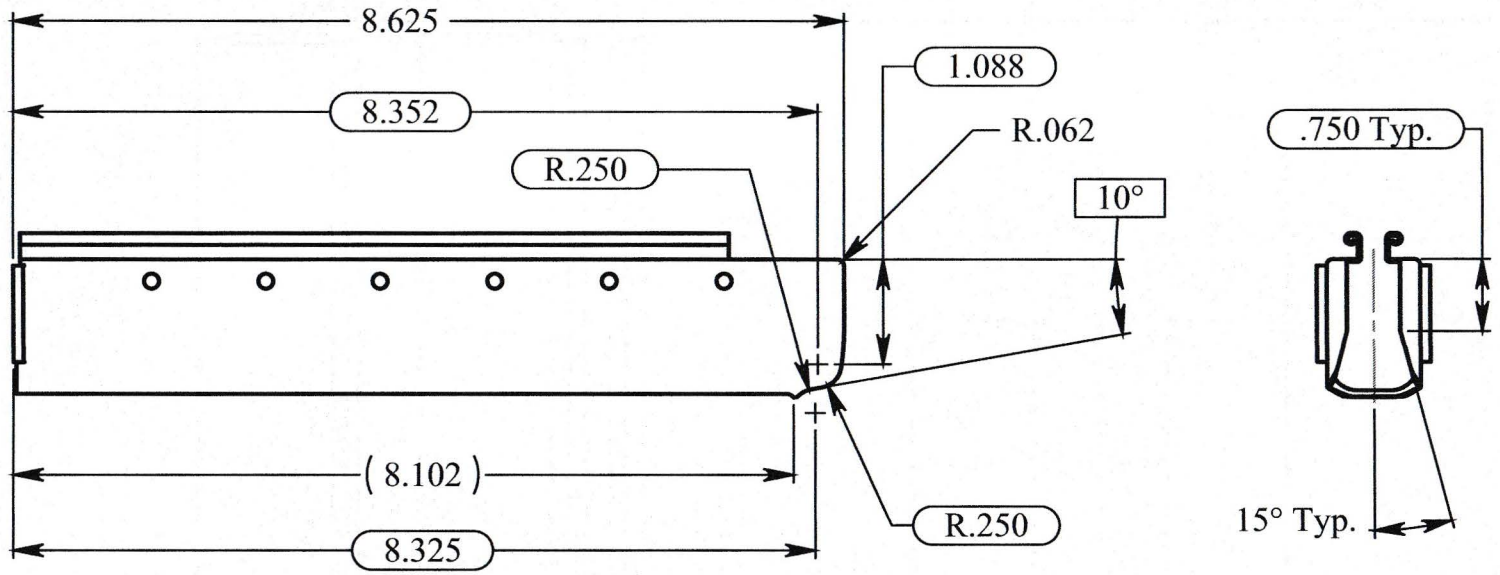
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Magazine
HARDNESS	OPERATION NAME: Rear Opening
FINISH	OPERATION NO.: 30 — SCALE: 1:2



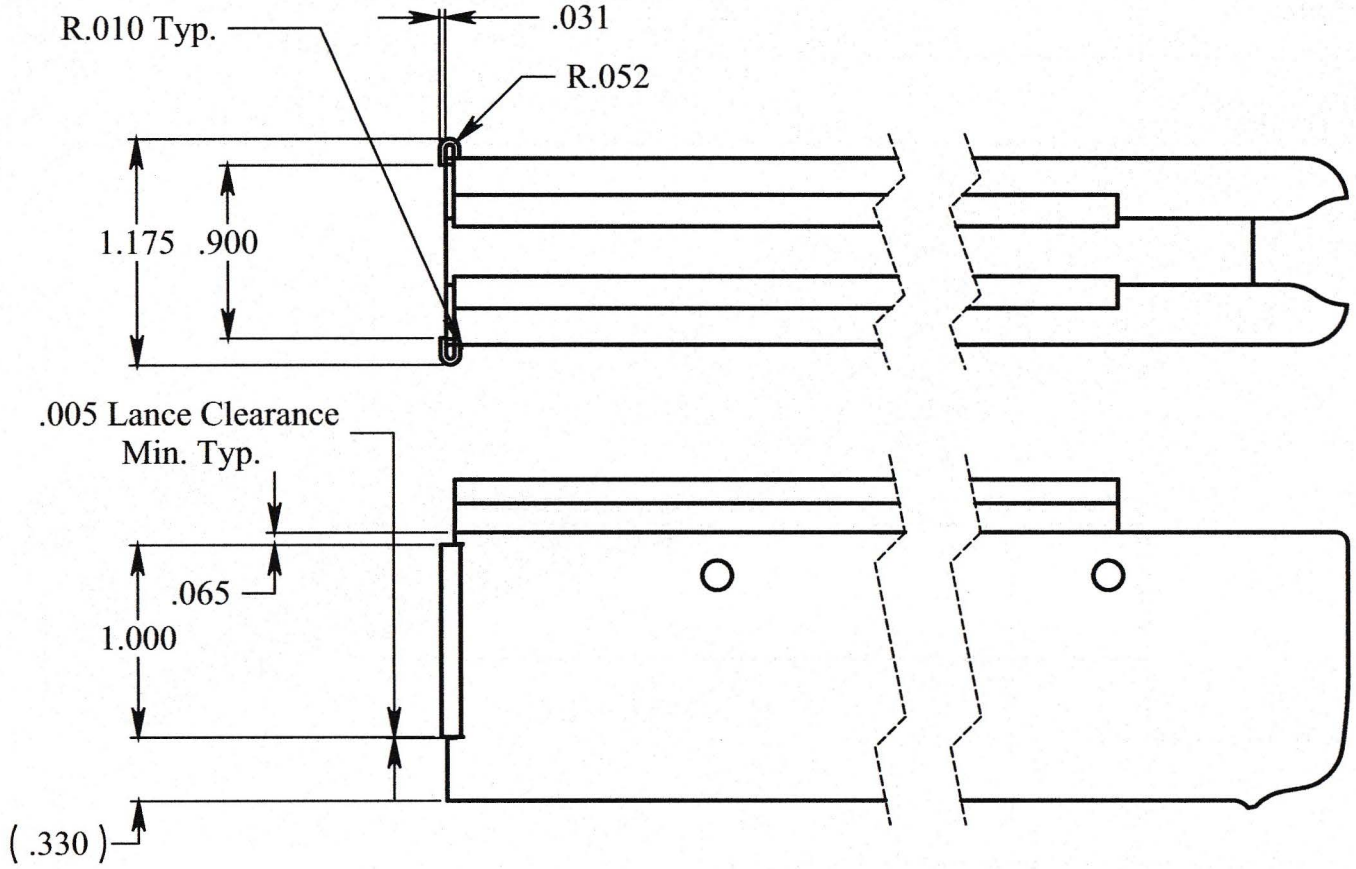
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

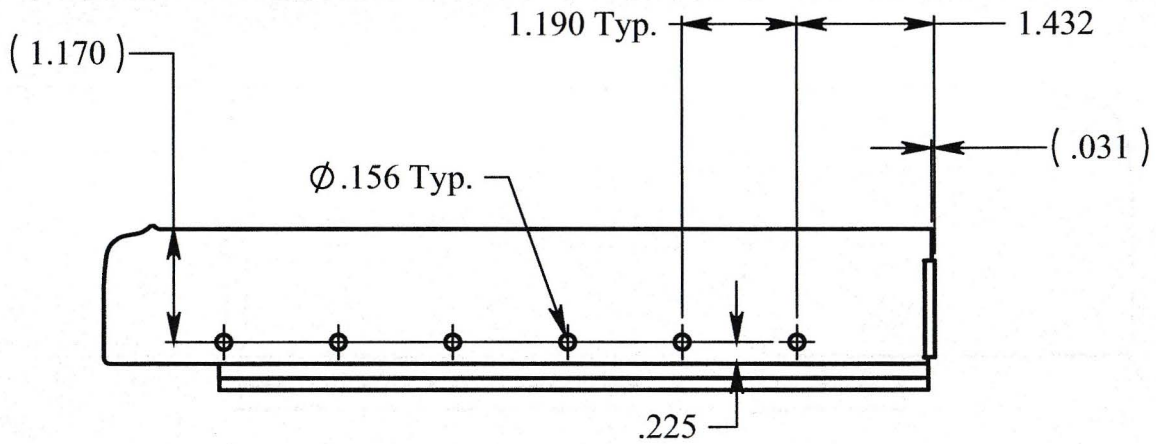
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

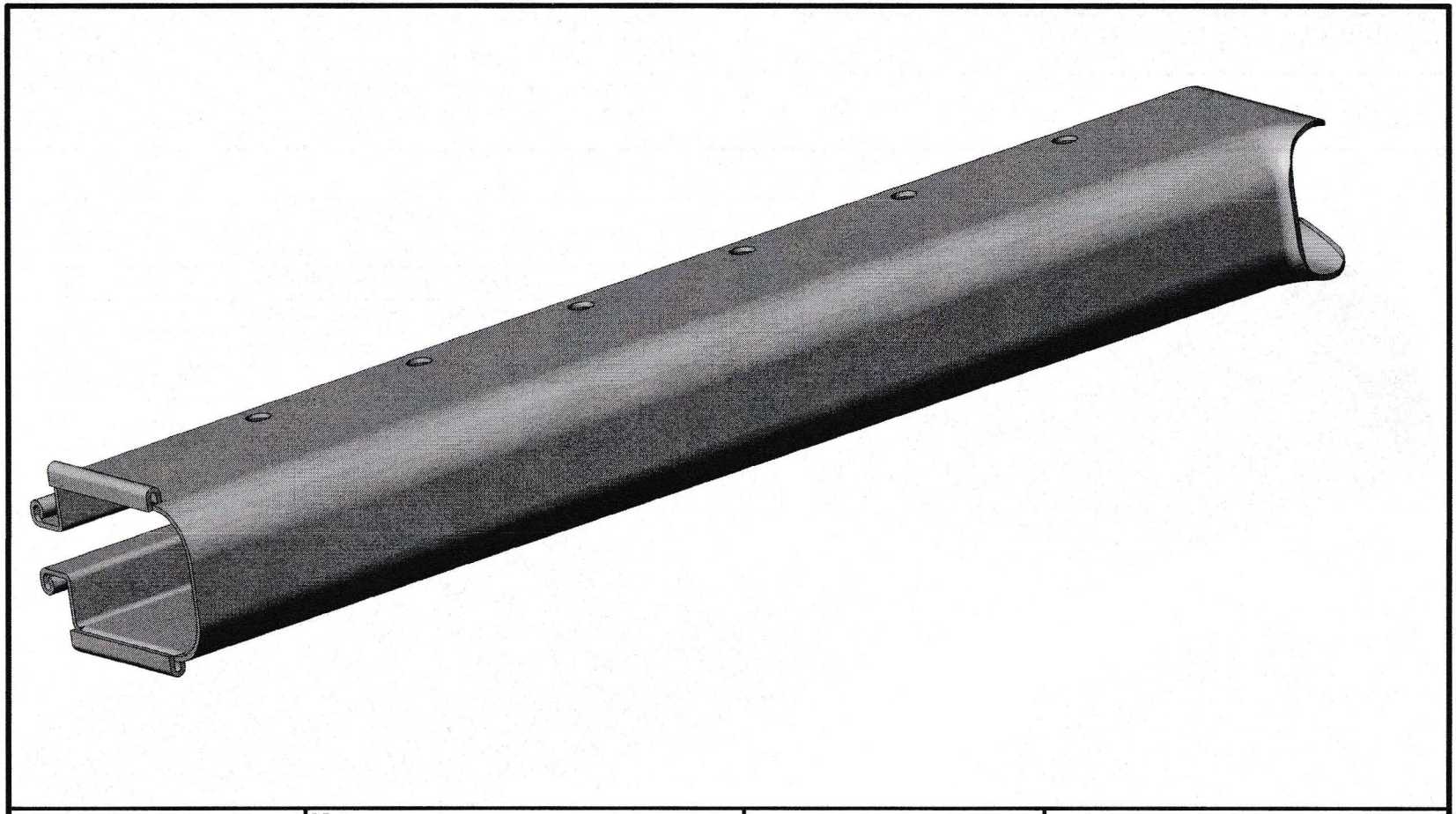
MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Magazine Box
HARDNESS	OPERATION NAME: Lip Geometry
FINISH	OPERATION NO.: 40
	SCALE: 1:2



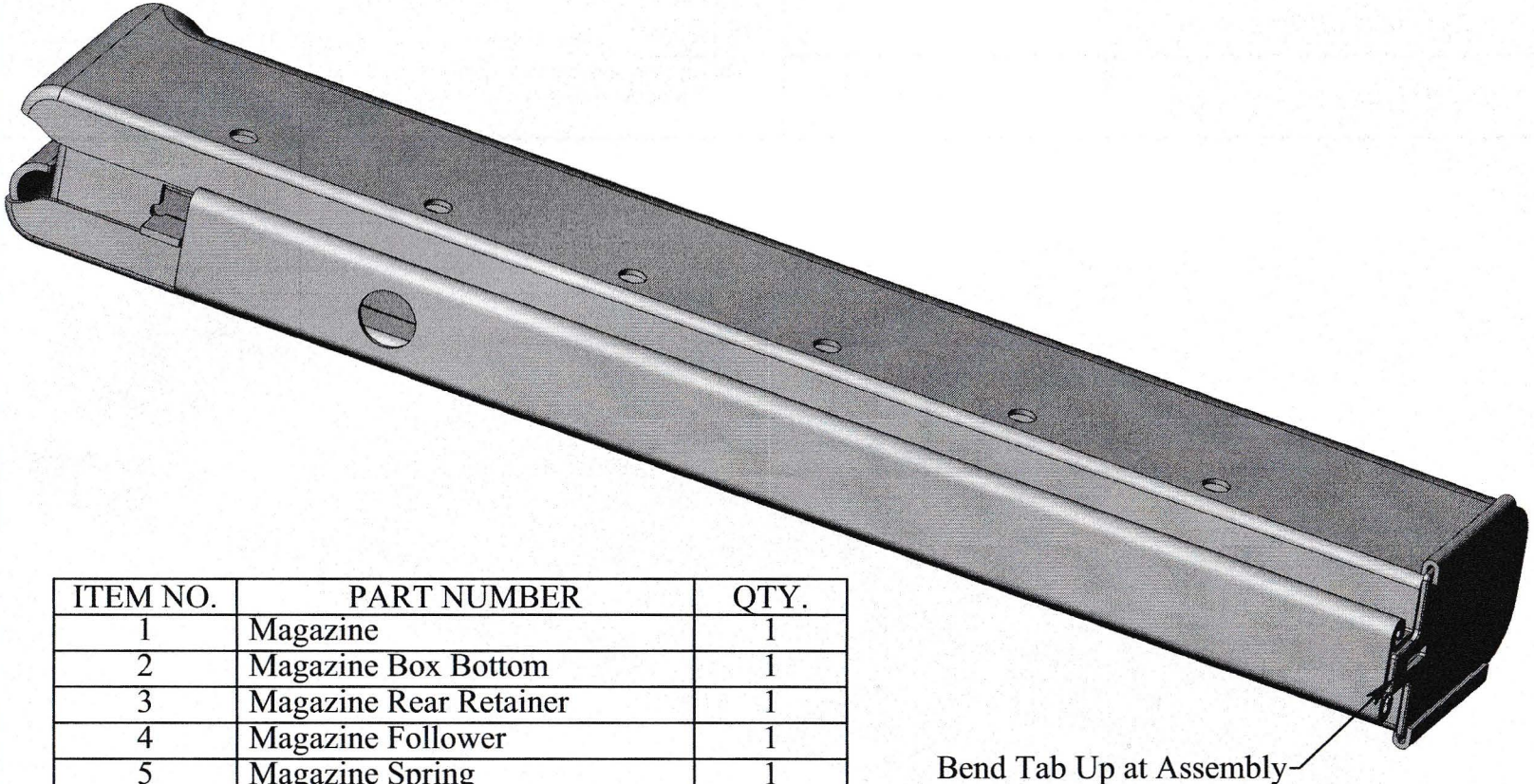
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Magazine Box OPERATION NAME: Bottom Retention OPERATION NO.: 50 SCALE: 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Magazine Box OPERATION NAME: Round Indicators OPERATION NO.: 60 SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)	MATERIAL AISI 1020	M1A1 Thompson	
		HEAT TREAT	PART NAME Magazine Box	
		HARDNESS	OPERATION NAME Color/Finishing	
		FINISH Black Oxide	OPERATION NO. 70	SCALE 1:1
	Proprietary and Confidential			



ITEM NO.	PART NUMBER	QTY.
1	Magazine	1
2	Magazine Box Bottom	1
3	Magazine Rear Retainer	1
4	Magazine Follower	1
5	Magazine Spring	1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH

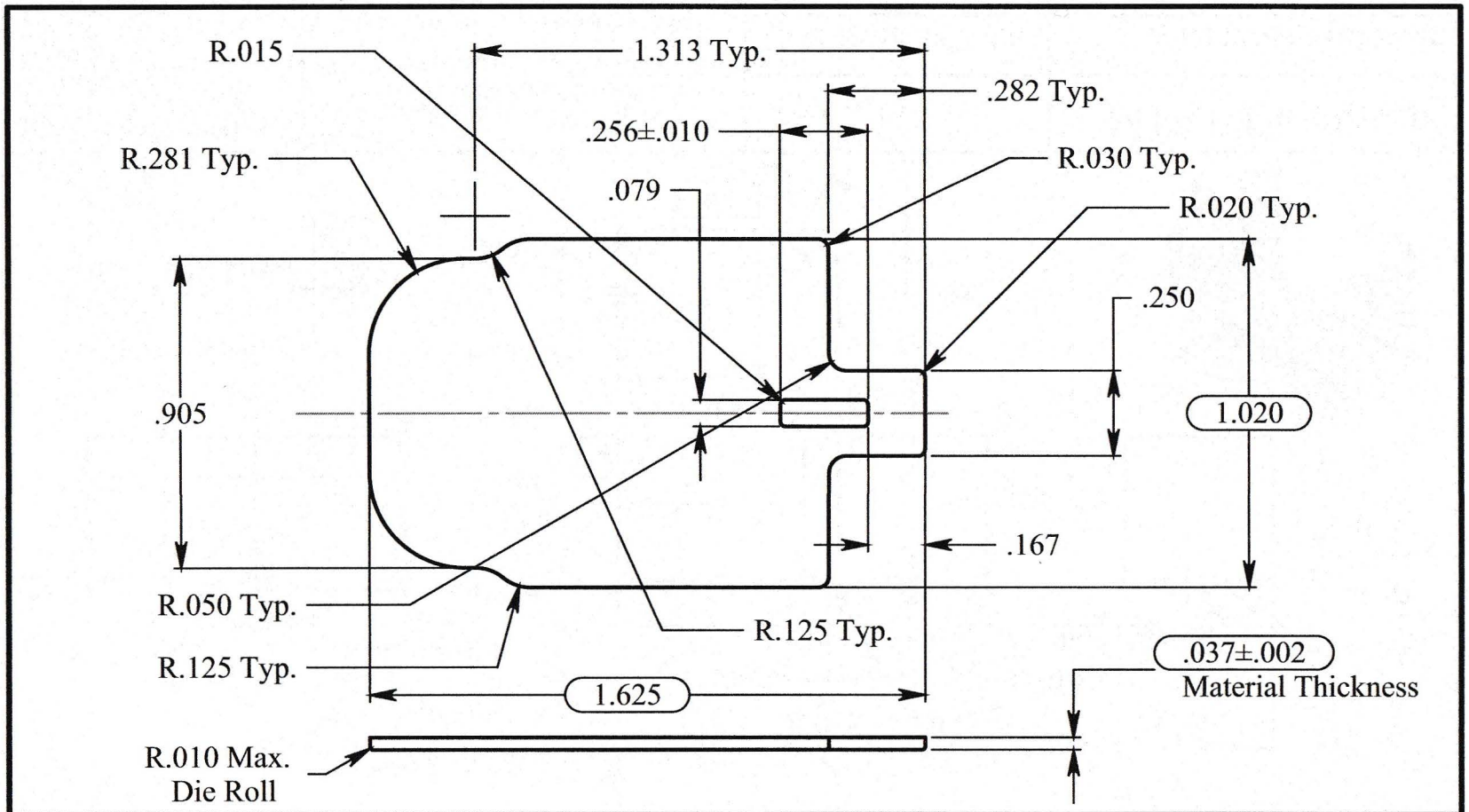
M1A1 Thompson

PART NAME
Magazine Box Assembly

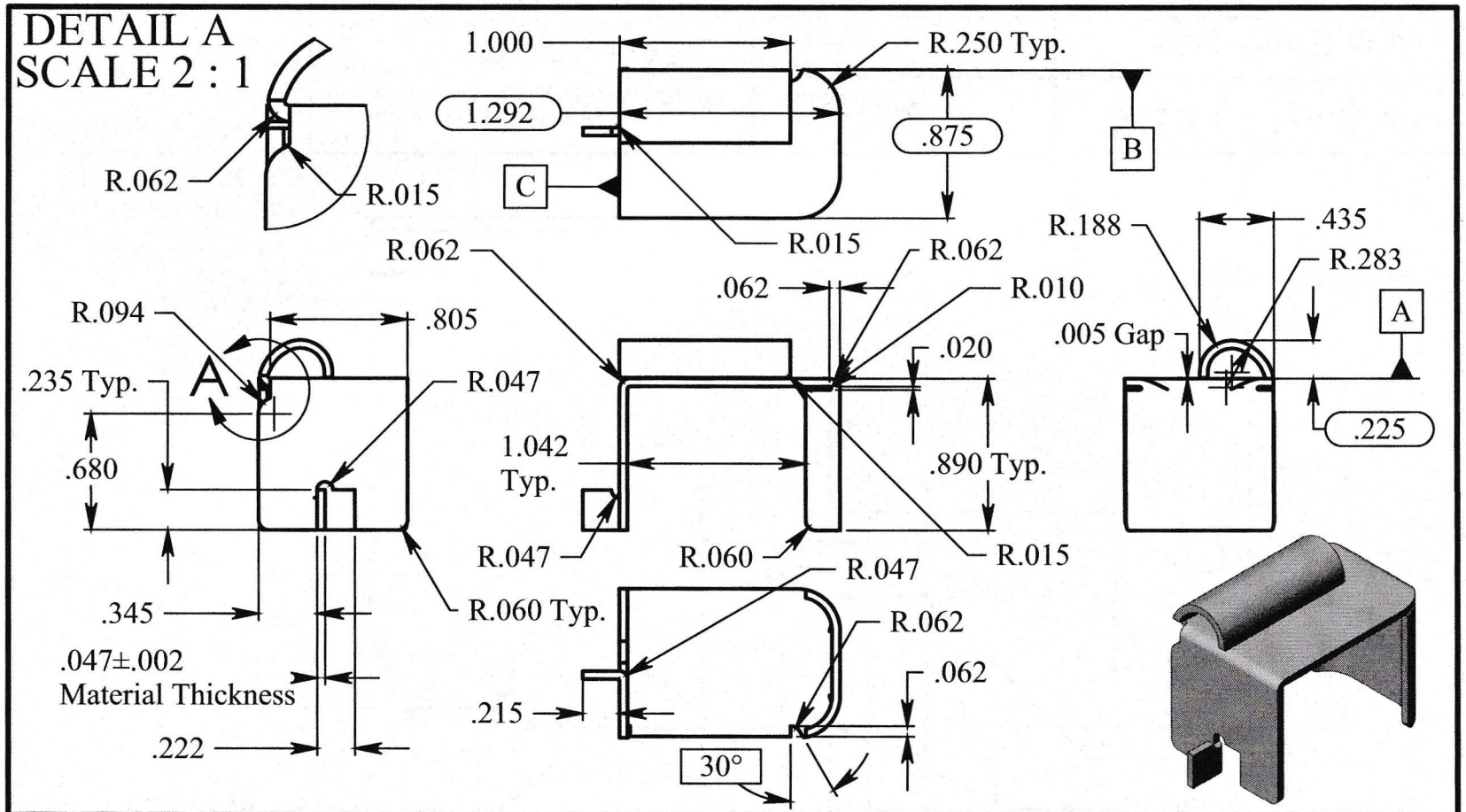
OPERATION NAME

OPERATION NO.

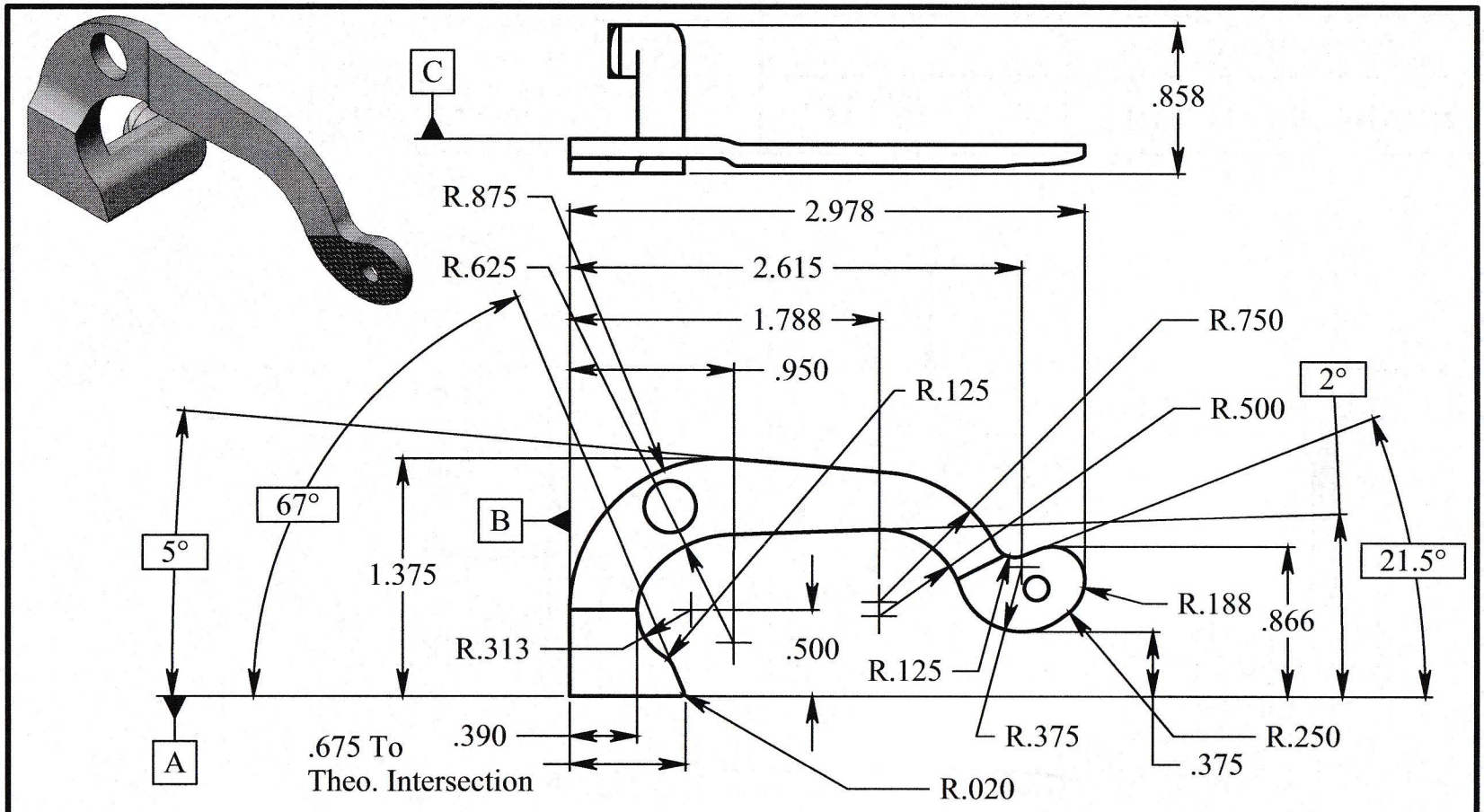
SCALE
1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL AISI 1118 HEAT TREAT None HARDNESS HRB 100 Min. FINISH Black Oxide	M1A1 Thompson PART NAME Mag. Box Bottom OPERATION NAME OPERATION NO. SCALE 2:1	



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX Proprietary and Confidential	MATERIAL AISI 1010 HEAT TREAT Case Hrdn .002-.004 HARDNESS HR15N 88-92 FINISH Black Oxide	M1A1 Thompson PART NAME Magazine Follower OPERATION NAME OPERATION NO. SCALE 1:1



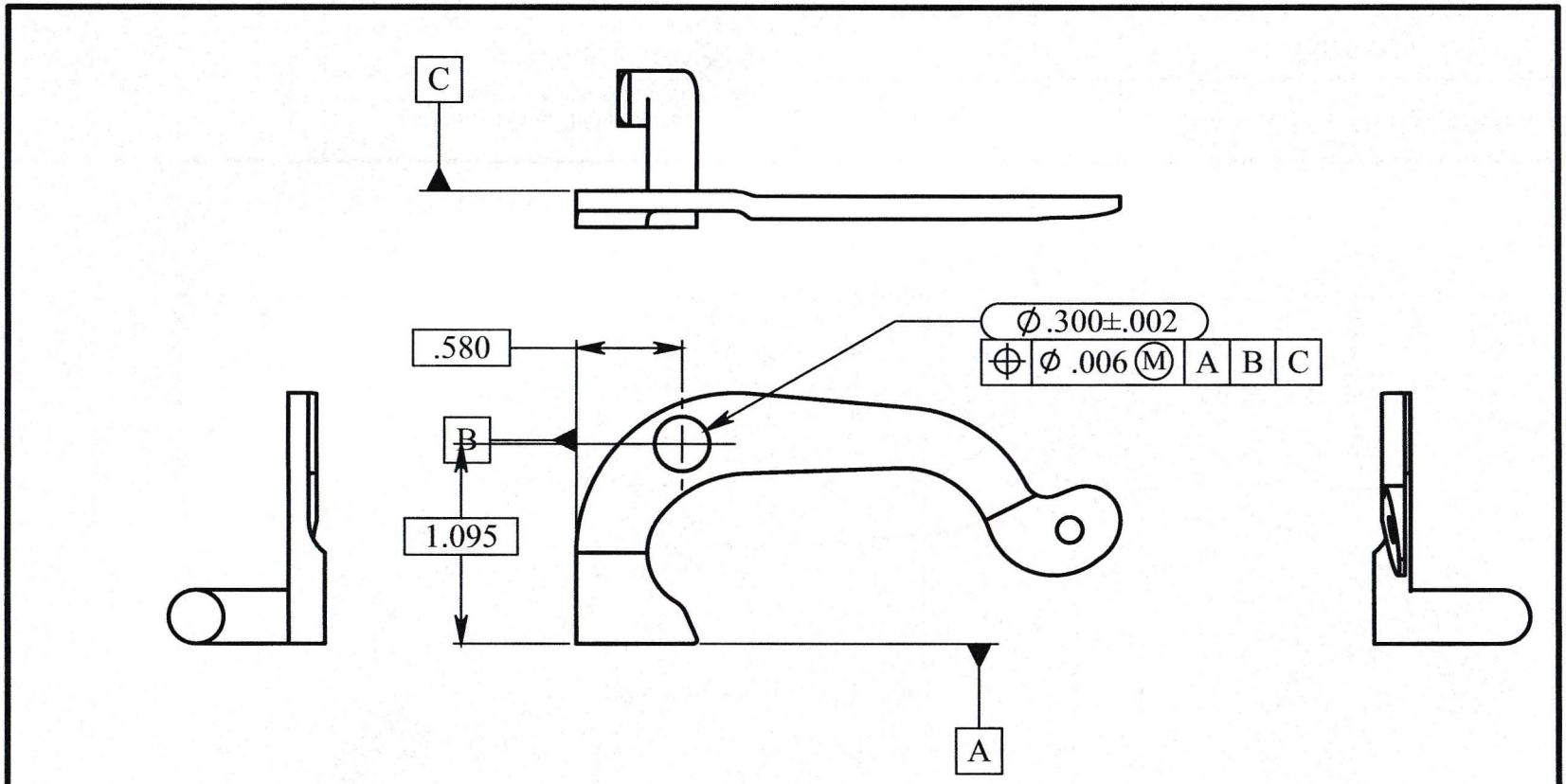
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

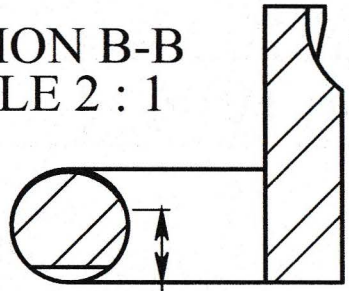
Proprietary and Confidential

MATERIAL: AISI 4140	M1A1 Thompson
HEAT TREAT	PART NAME: Magazine Latch
HARDNESS	OPERATION NAME: Side Profile
FINISH	OPERATION NO.: 10 — SCALE: 1:1

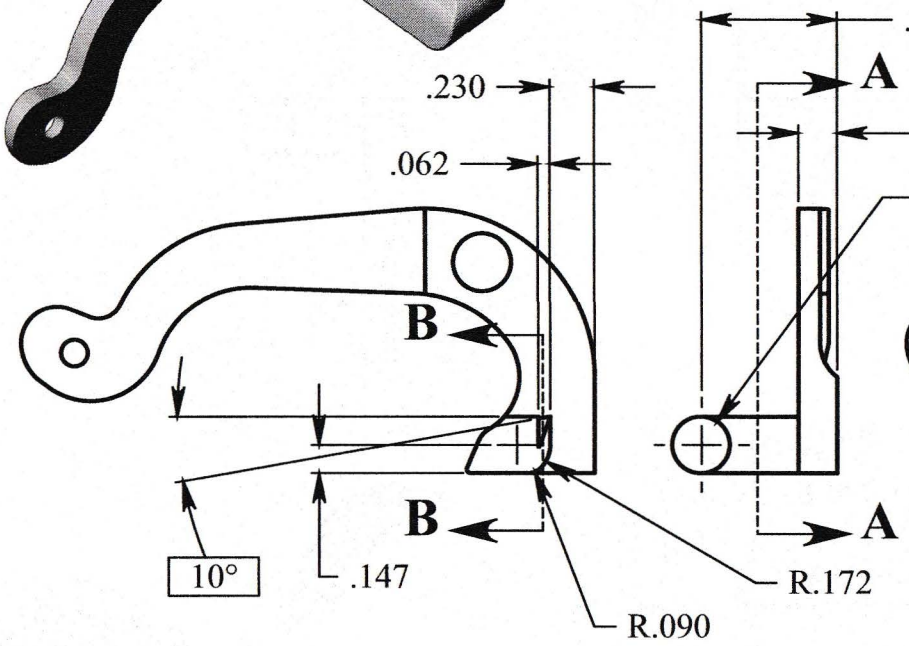


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 4140	M1A1 Thompson
		HEAT TREAT	PART NAME Magazine Latch
		HARDNESS	OPERATION NAME Pivot Hole
	Proprietary and Confidential	FINISH	OPERATION NO. 20 / SCALE 1:1

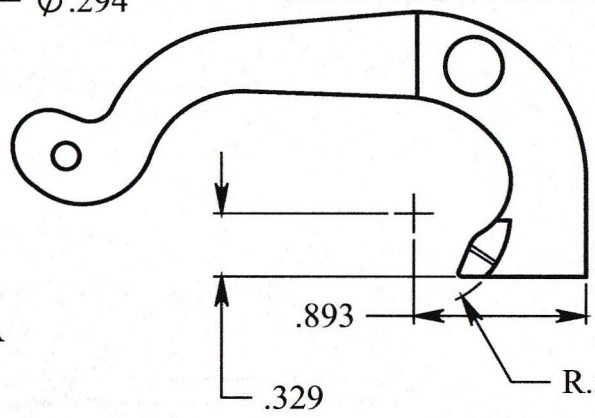
SECTION B-B
SCALE 2 : 1



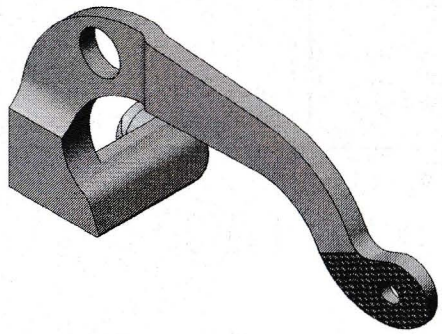
.19 Latch Cut Runout

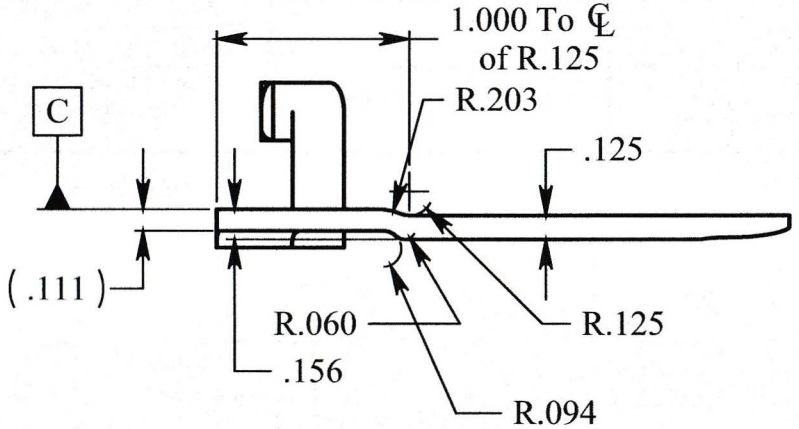


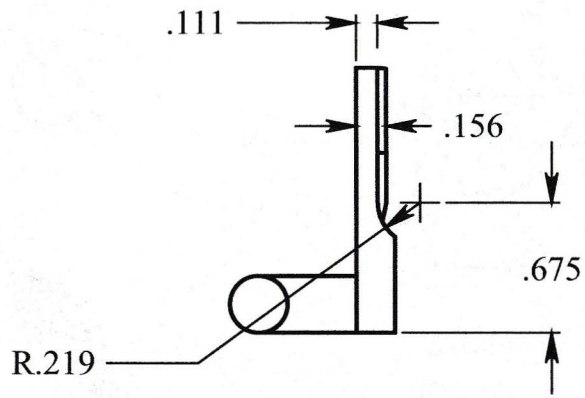
SECTION A-A

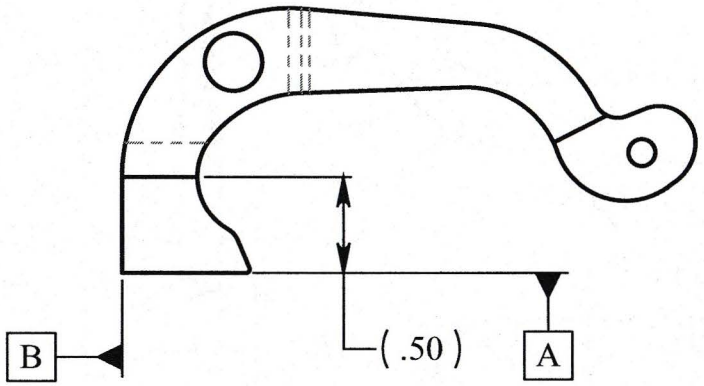


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL AISI 4140 HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME Magazine Latch OPERATION NAME Latch Surface OPERATION NO. 30 SCALE 1:1









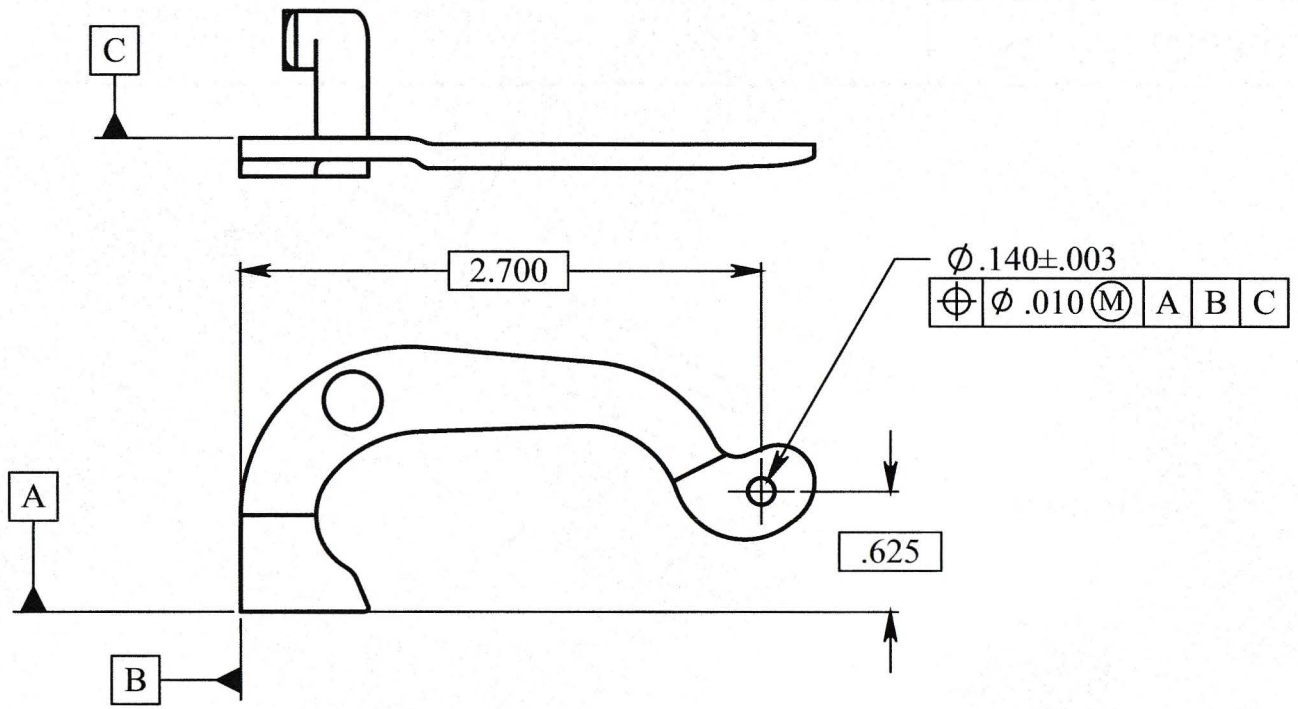
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

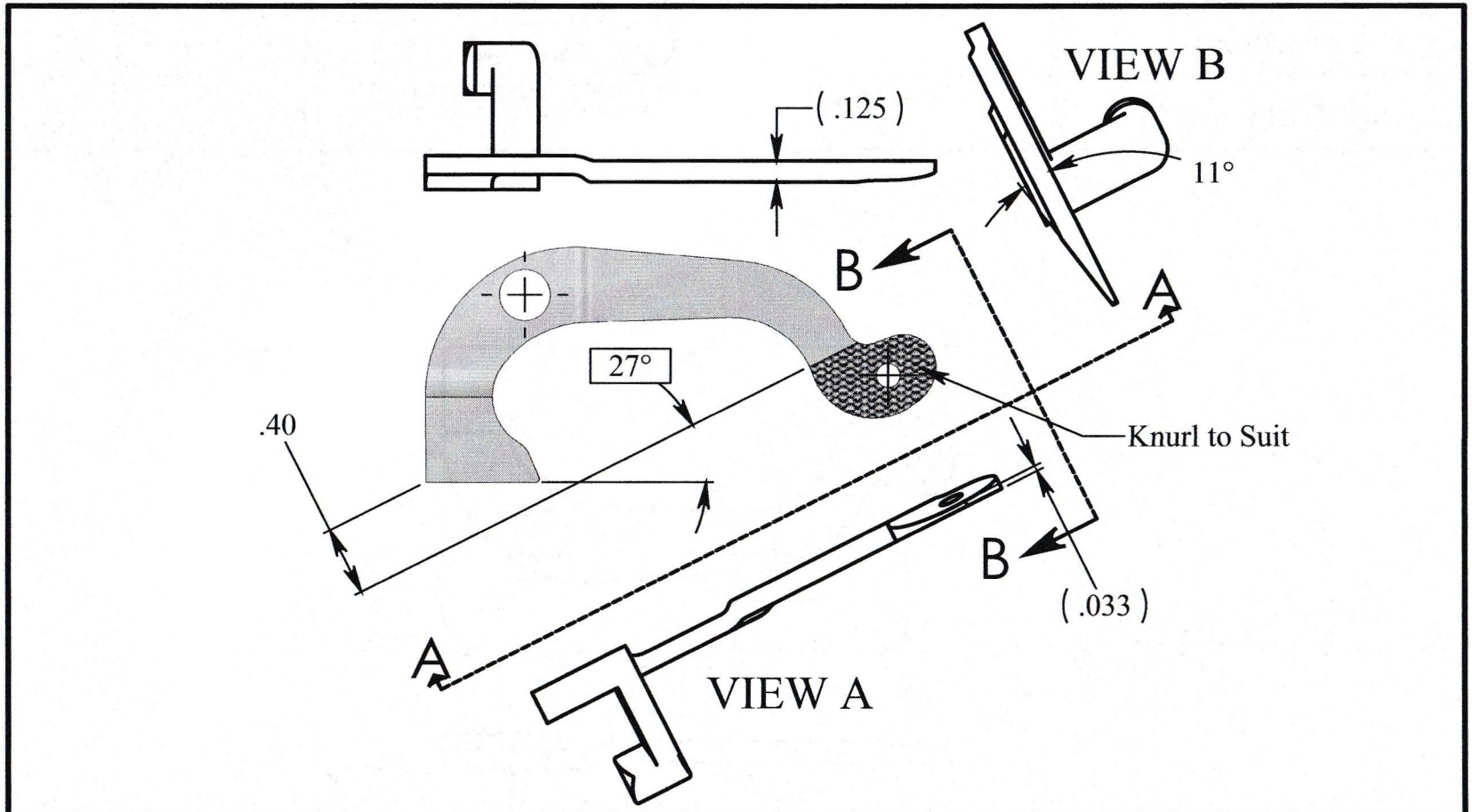
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 4140	M1A1 Thompson
HEAT TREAT	PART NAME: Magazine Latch
HARDNESS	OPERATION NAME: Lever Arm
FINISH	OPERATION NO.: 40 — SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL: AISI 4140 HEAT TREAT: HARDNESS: FINISH:	M1A1 Thompson PART NAME: Magazine Latch OPERATION NAME: Lever Hole OPERATION NO.: 50 SCALE: 1:1



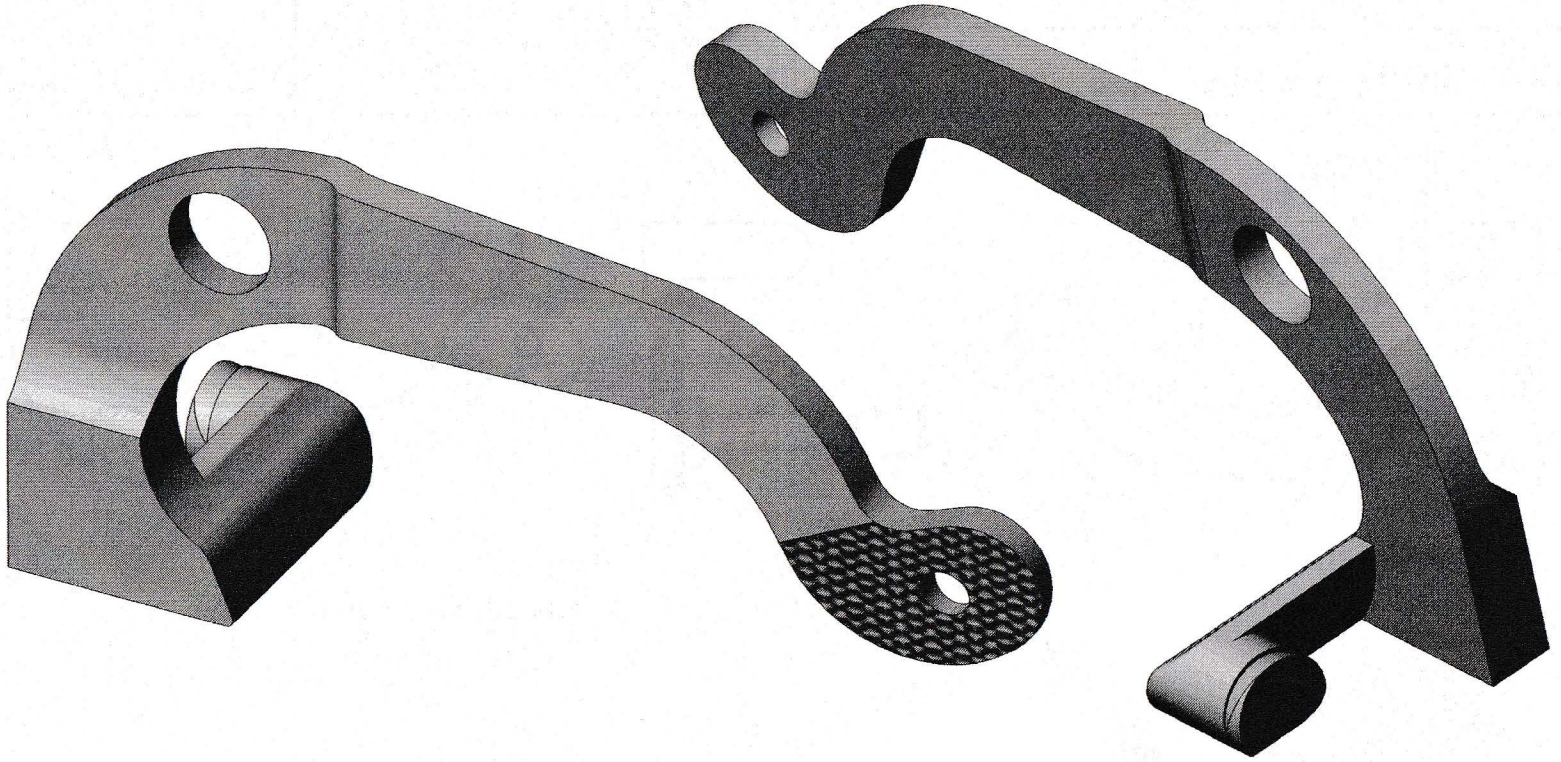
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

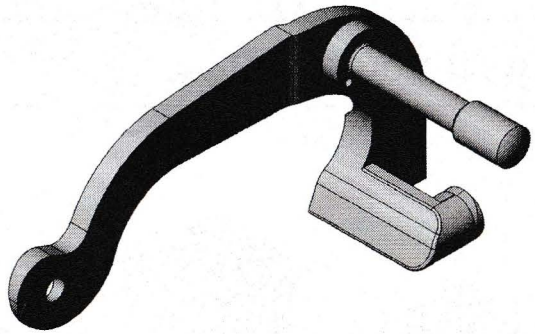
Proprietary and Confidential

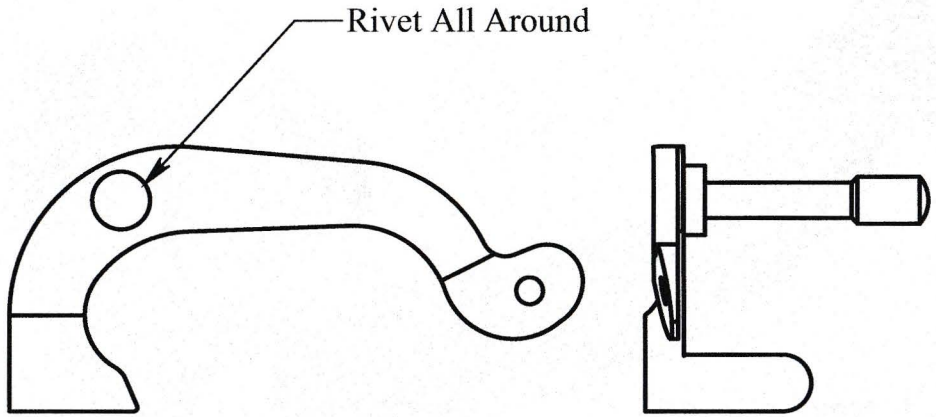
MATERIAL: AISI 4140	M1A1 Thompson
HEAT TREAT	PART NAME: Magazine Latch
HARDNESS	OPERATION NAME: Angled Surface
FINISH	OPERATION NO.: 60
	SCALE: 1:1

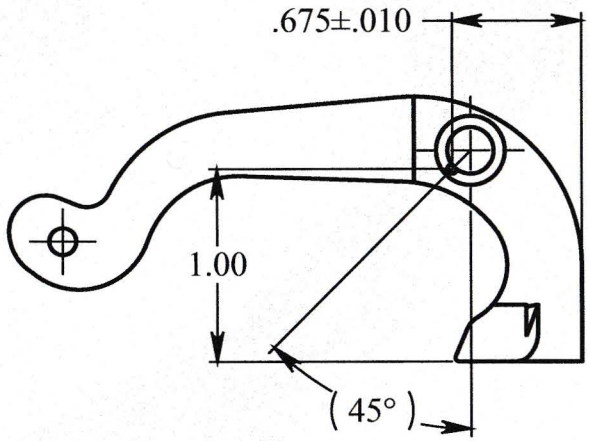


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 4140	M1A1 Thompson	
		HEAT TREAT Harden &Temper	PART NAME Magazine Latch	
		HARDNESS HRC 40 - 45	OPERATION NAME Heat Treat	
		FINISH	OPERATION NO. 70	SCALE 2:1
	Proprietary and Confidential			

ITEM NO.	PART NUMBER	QTY.
1	Magazine Latch	1
2	Mag. Latch Pivot	1







Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)

Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Magazine Latch Assembly
HARDNESS	OPERATION NAME
FINISH: Mag. Phosphate	OPERATION NO. / SCALE: 1:1

Manufaturing Data:

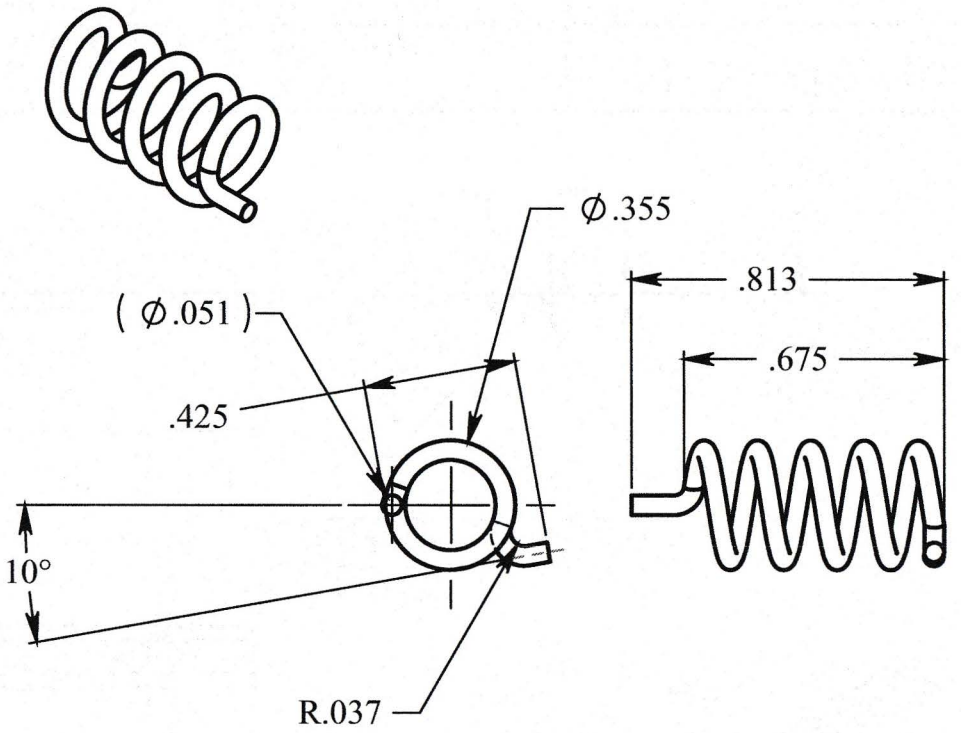
Spring Type:	Torsion
Outside Diameter:	.355 inches
Wire Diameter:	.051
Total Coils:	4.5
Active Coils:	4.5
Coil Pitch:	.131
Body Length:	.675
Wind Direction:	Right Hand

Inspection Data:

Arm Angle:	240 deg
Torsional Moment:	2.15 lbs-in
% of Mat. Tensile:	54%
Spring works in:	.375 diameter hole
Spring works over:	.188 diameter rod

Engineering Data:

Spring Rate:	.036 lbs-in/deg
Spring Index:	6.0



Dimensions are in Inches

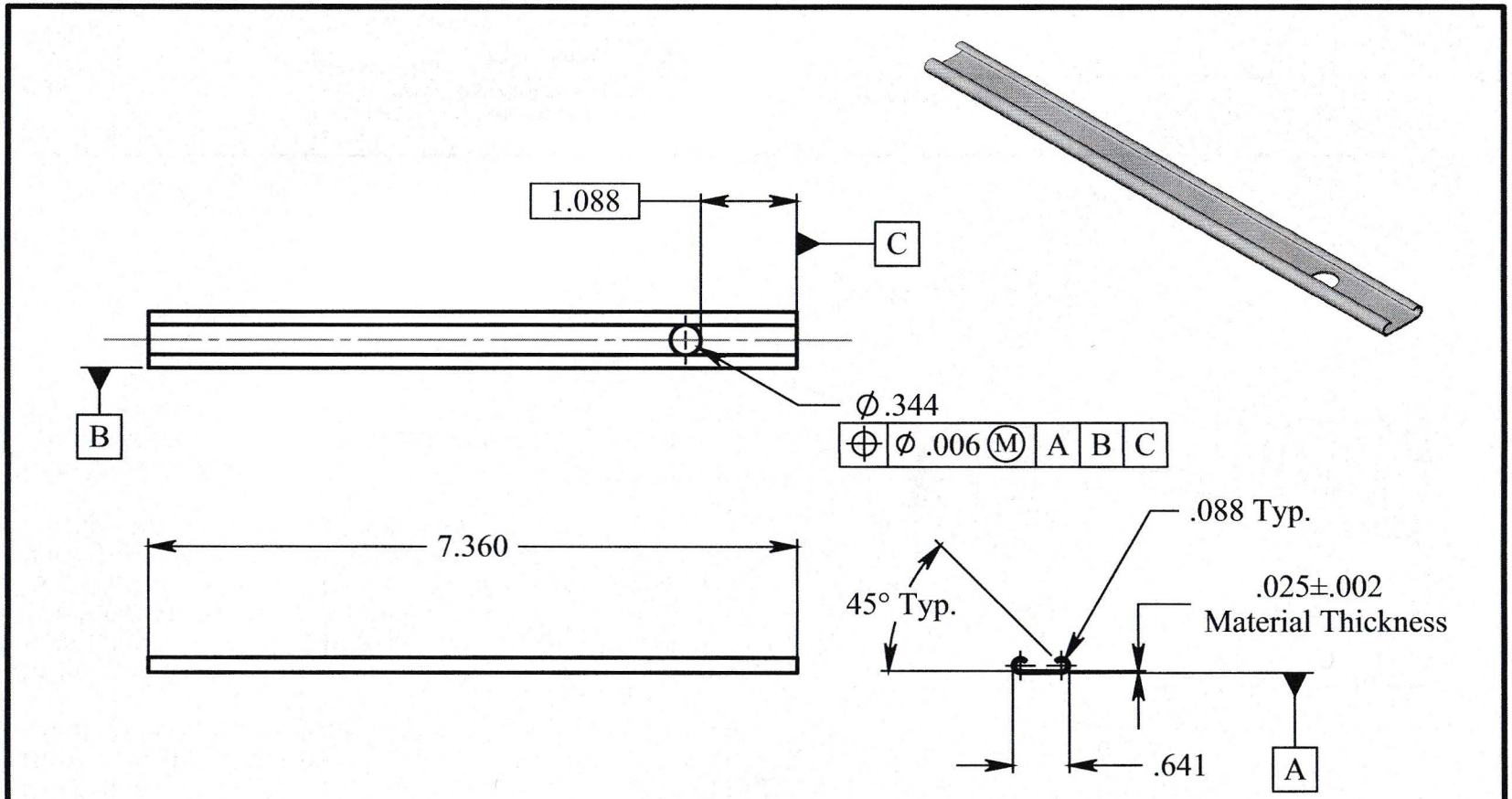
Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: Music Wire ASTM - A228	M1A1 Thompson	
HEAT TREAT: Stress Relieve	PART NAME: Mag. Latch Spring	
HARDNESS	OPERATION NAME	
FINISH	OPERATION NO.	SCALE: 2:1



Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

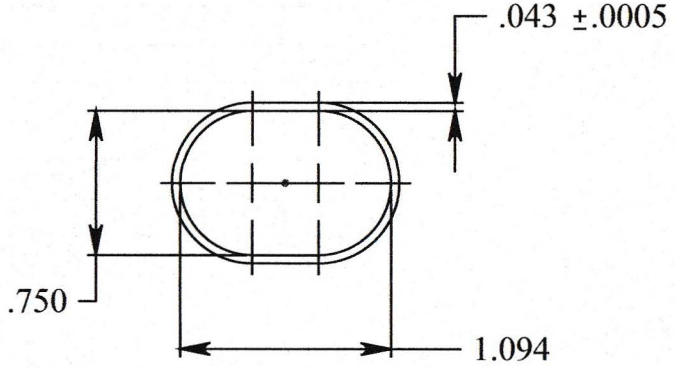
MATERIAL: AISI 1010	M1A1 Thompson
HEAT TREAT: None	PART NAME: Magazine Retainer
HARDNESS: HRB 100 Min.	OPERATION NAME:
FINISH: Black Oxide	OPERATION NO.: / SCALE: 1:2

Inspection Data:

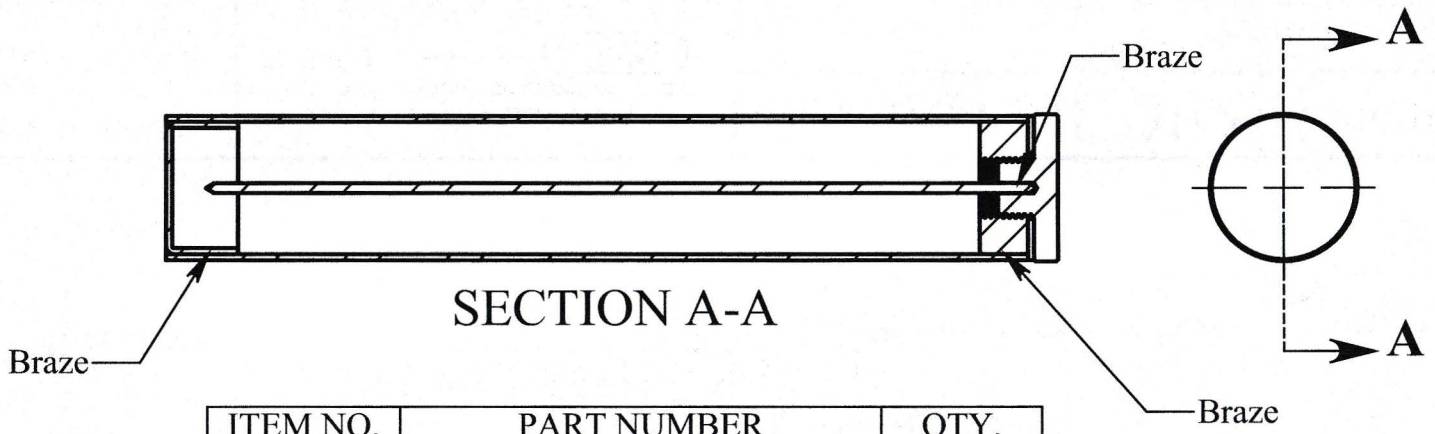
1. To work freely in a 1.185 x .841 rectangle
2. Load @ 3.500 = 2.8 Lbs +/- .25 lbs.
3. Solid Height Max.= .935
4. Wind = Right Hand
5. Free Length Minimum = 11.00

Manufacturing Data:

Free Length = 11.50
Coils Total = 20
Coils Active = 20
Ends = Plain
Wire Diameter = .043
Material = Music Wire (ASTM A228)
Heat Treat = Stress Relieve



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL Music Wire ASTM A228	M1A1 Thompson
		HEAT TREAT Stress Relieve	PART NAME Magazine Spring
		HARDNESS	OPERATION NAME
		FINISH	OPERATION NO. / SCALE 4:1
	Proprietary and Confidential		



ITEM NO.	PART NUMBER	QTY.
1	Oiler Gasket	1
2	Oiler Main Body Assembly	1
	Oiler Body	1
	Oiler Bottom	1
	Oiler Threaded Insert	1
3	Oiler Top	1
	Oiler Cap	1
	Oiler Stem	1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH

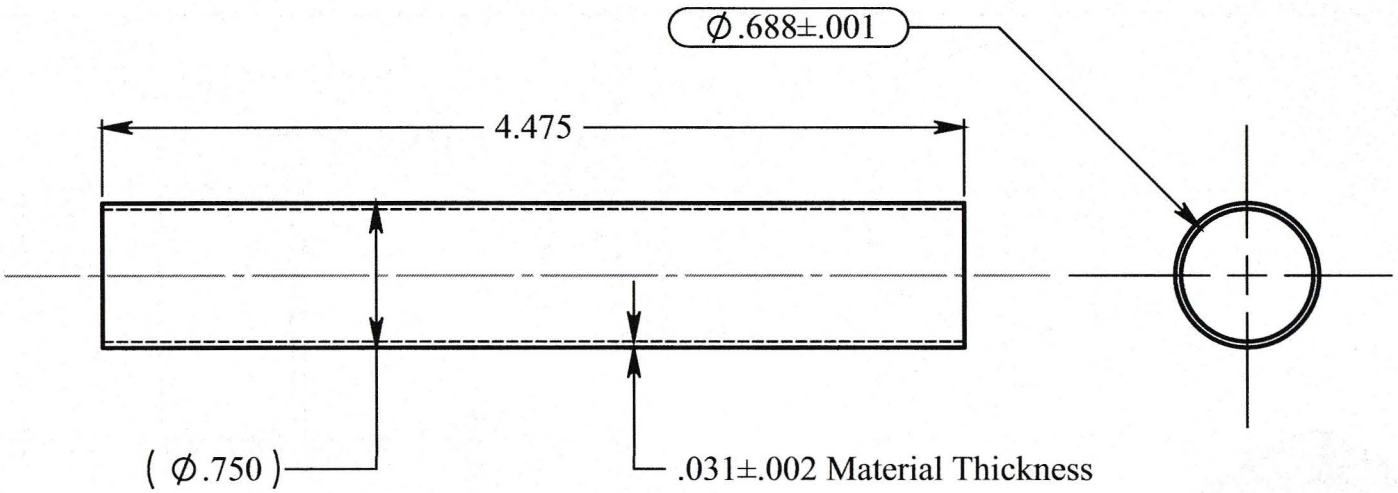
M1A1 Thompson

PART NAME Oiler Assembly

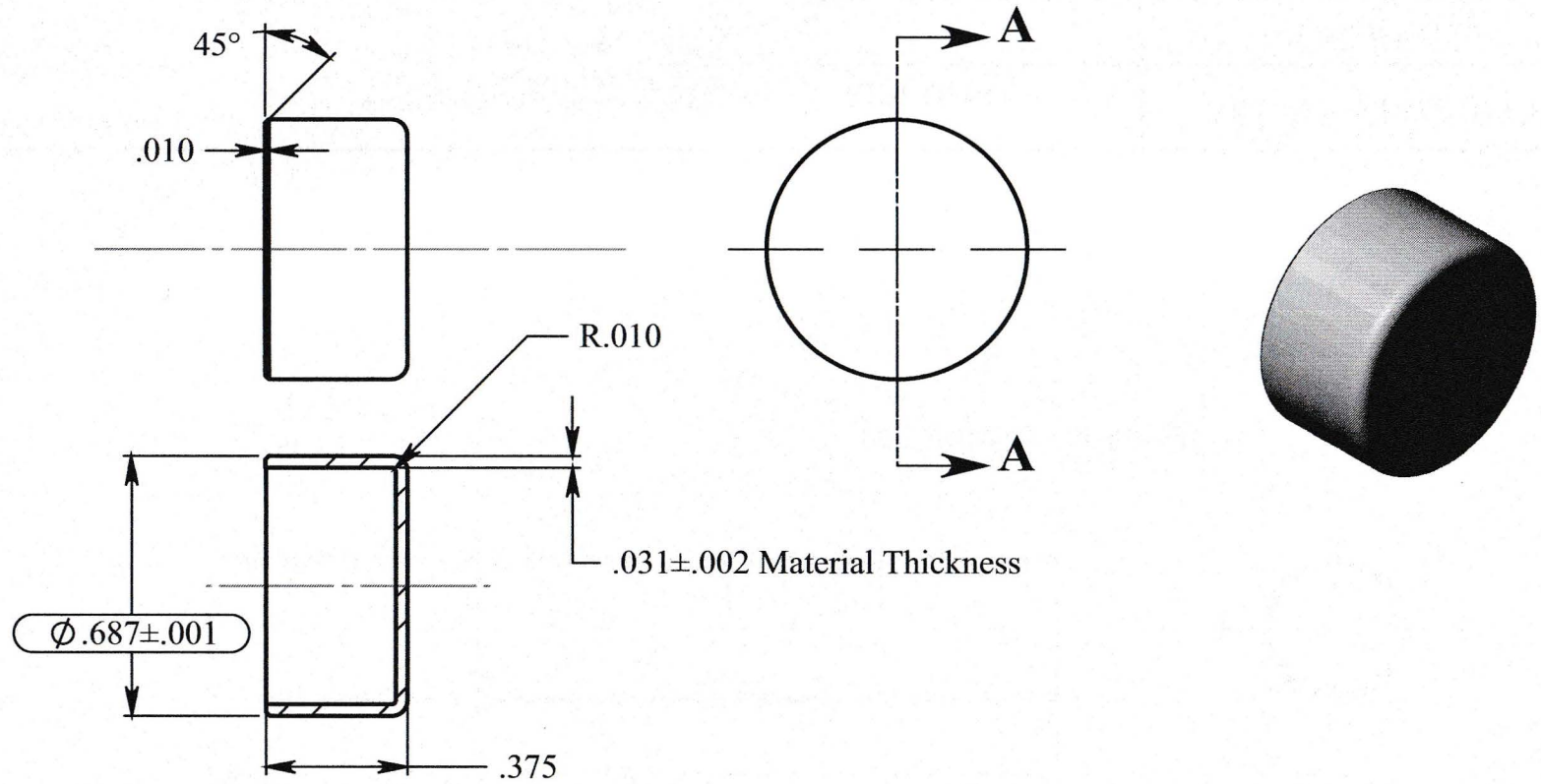
OPERATION NAME

OPERATION NO.

SCALE 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL AISI 1010	M1A1 Thompson	
		HEAT TREAT	PART NAME Oiler Body	
		HARDNESS	OPERATION NAME	
		FINISH	OPERATION NO.	SCALE 1:1
	Proprietary and Confidential			



SECTION A-A

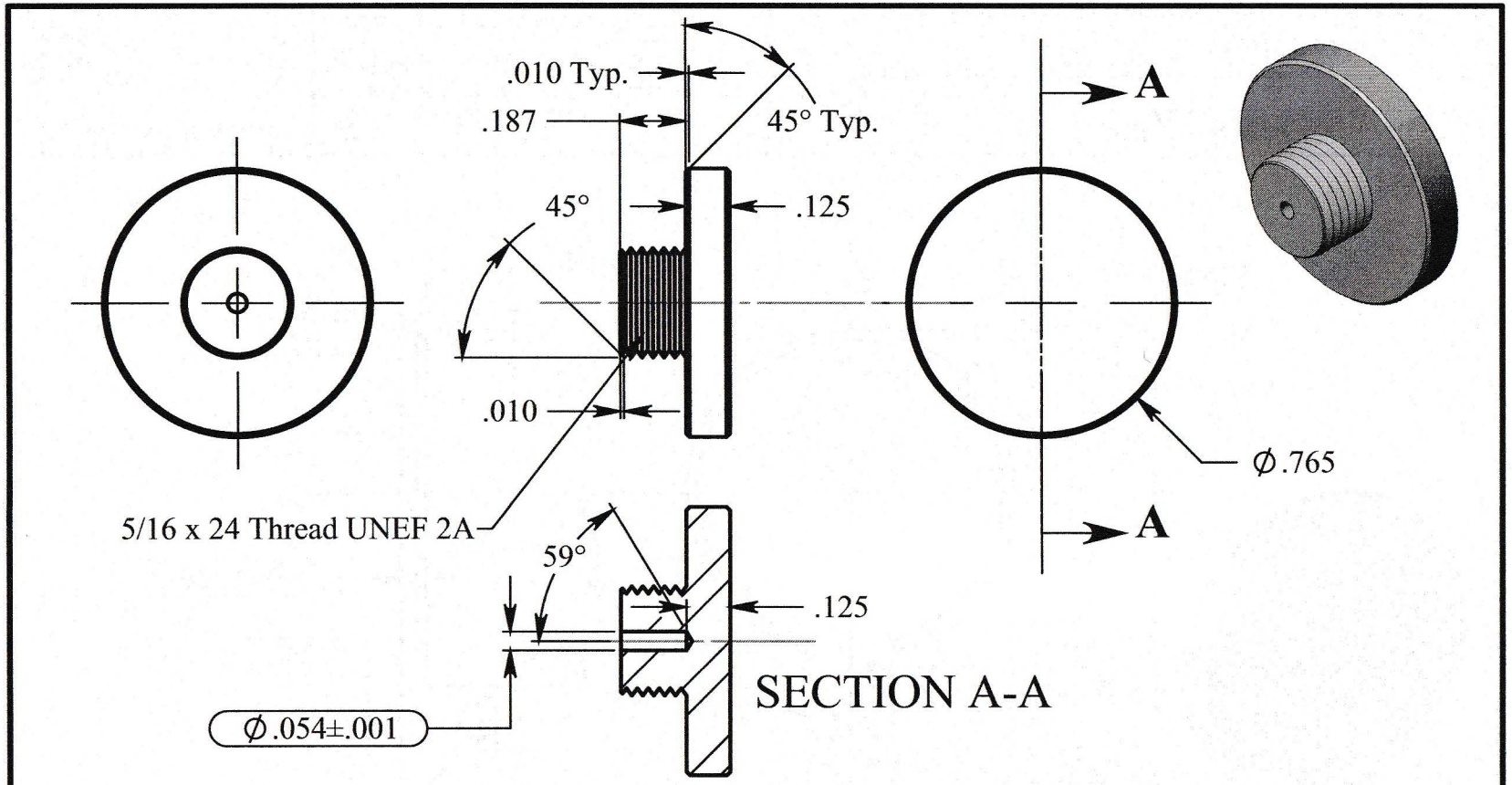
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

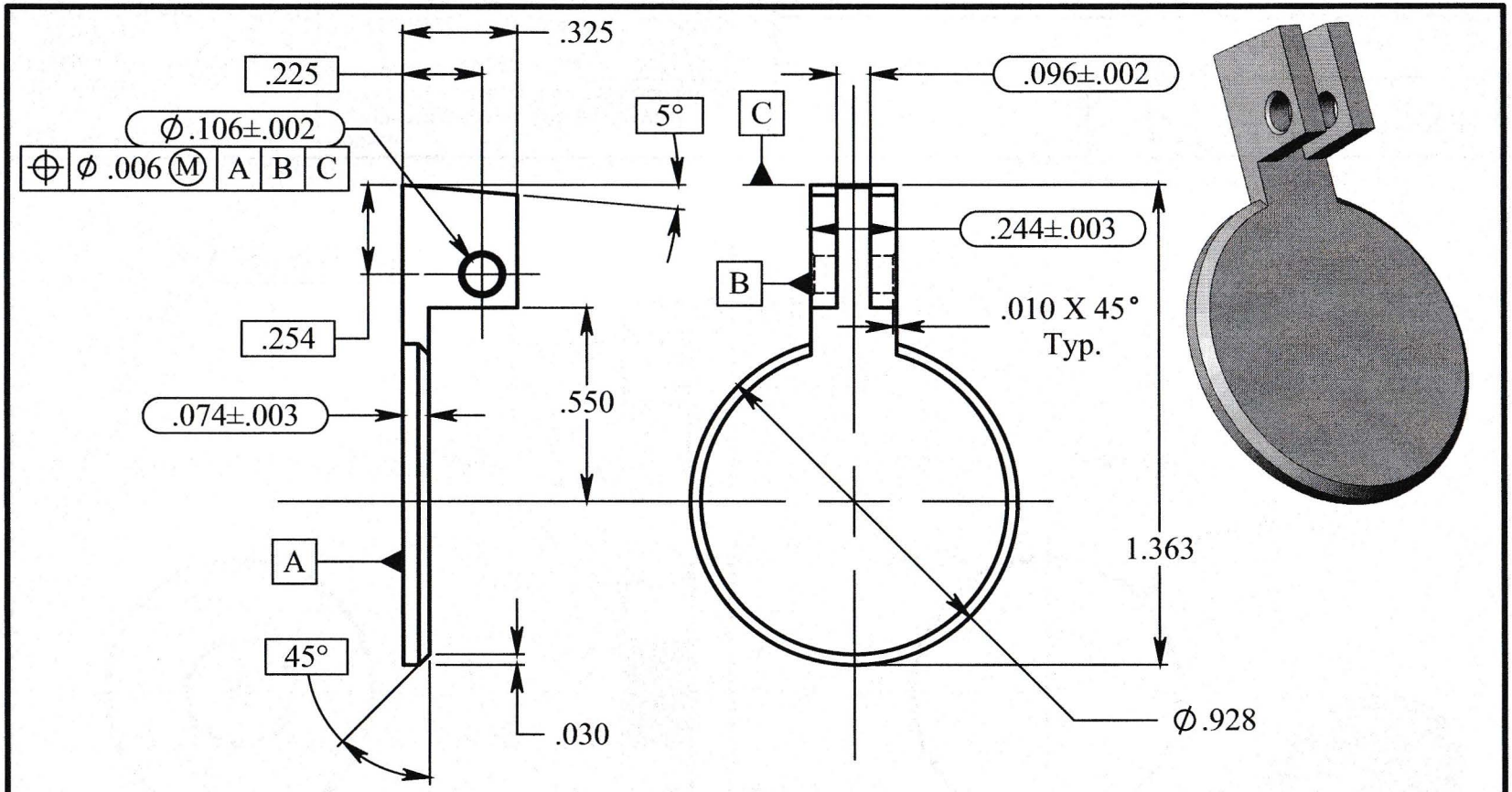
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

MATERIAL: AISI 1010	M1A1 Thompson
HEAT TREAT	PART NAME: Oiler Bottom
HARDNESS	OPERATION NAME
FINISH	OPERATION NO. / SCALE: 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)	MATERIAL AISI 1215	M1A1 Thompson
		HEAT TREAT	PART NAME Oiler Cap
		HARDNESS	OPERATION NAME
		FINISH	OPERATION NO. / SCALE 2:1
	Proprietary and Confidential		



Dimensions are in Inches

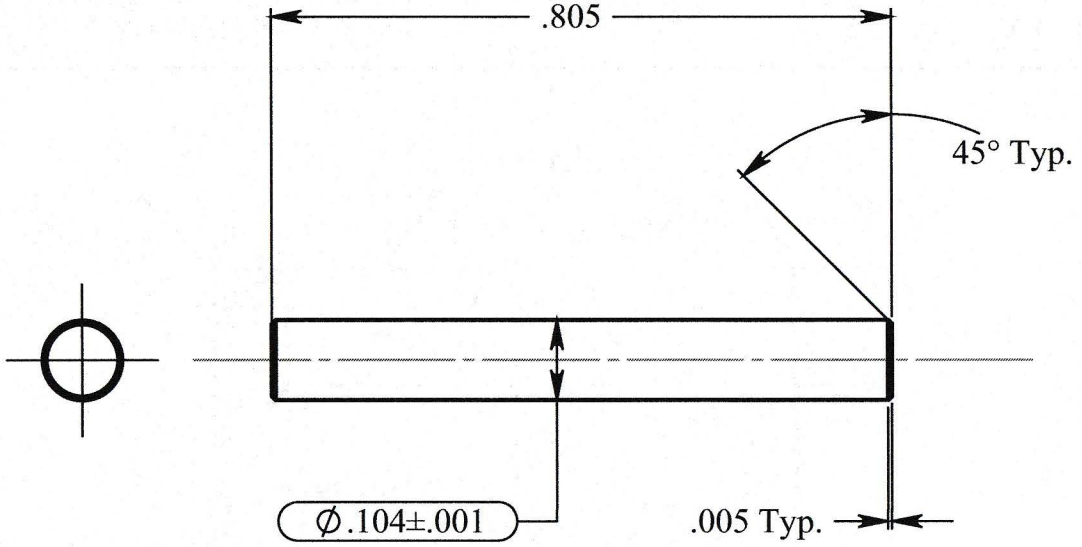
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX

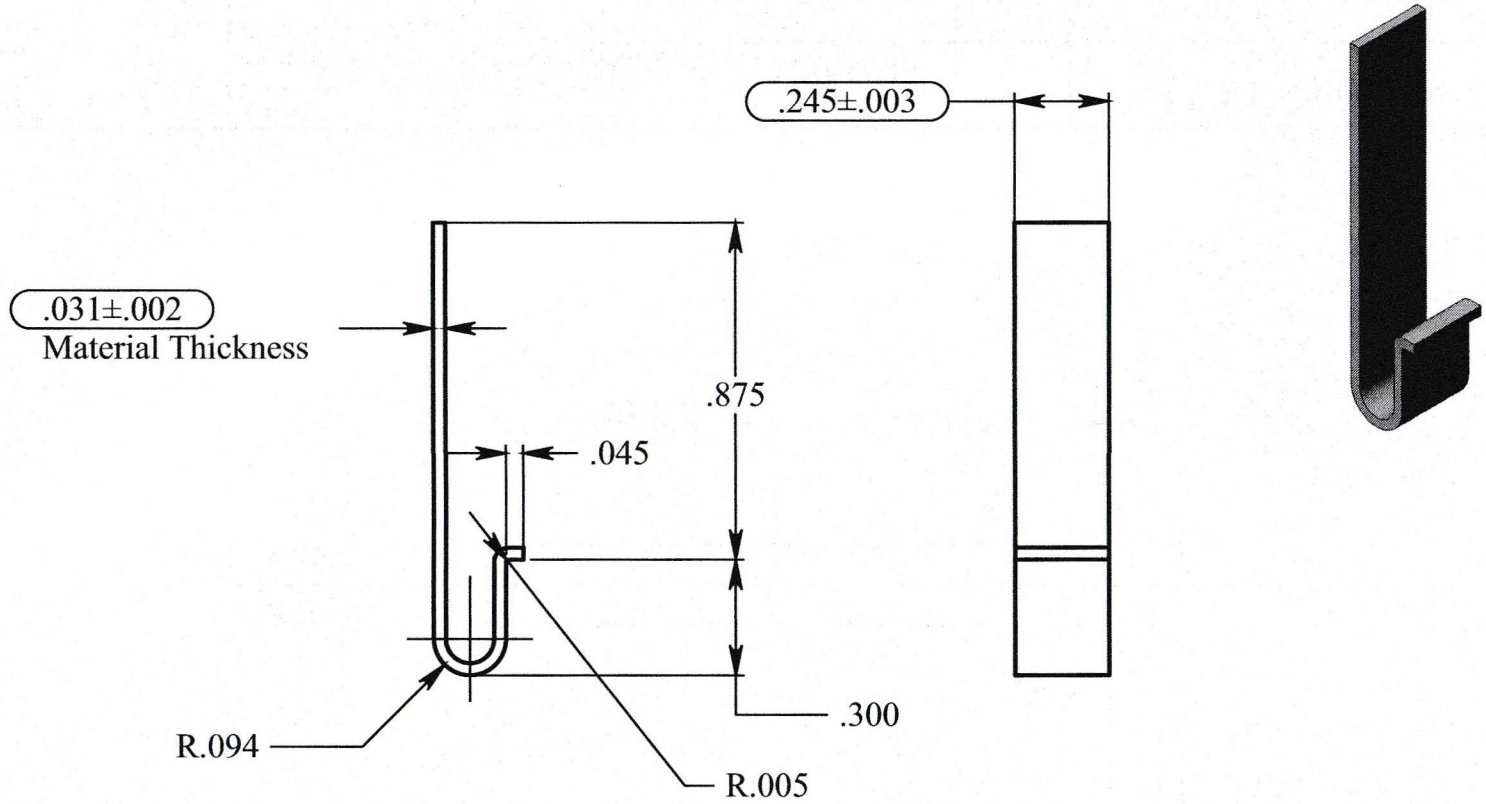
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1118	M1A1 Thompson
HEAT TREAT	PART NAME: Oiler Door
HARDNESS	OPERATION NAME
FINISH: Black Oxide	OPERATION NO. / SCALE: 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX Proprietary and Confidential	MATERIAL AISI 1095	M1A1 Thompson	
		HEAT TREAT Neutral Salt Harden	PART NAME Oiler Door Pivot Pin	
		HARDNESS HRC 48-53	OPERATION NAME	
		FINISH Black Oxide	OPERATION NO.	SCALE 4:1



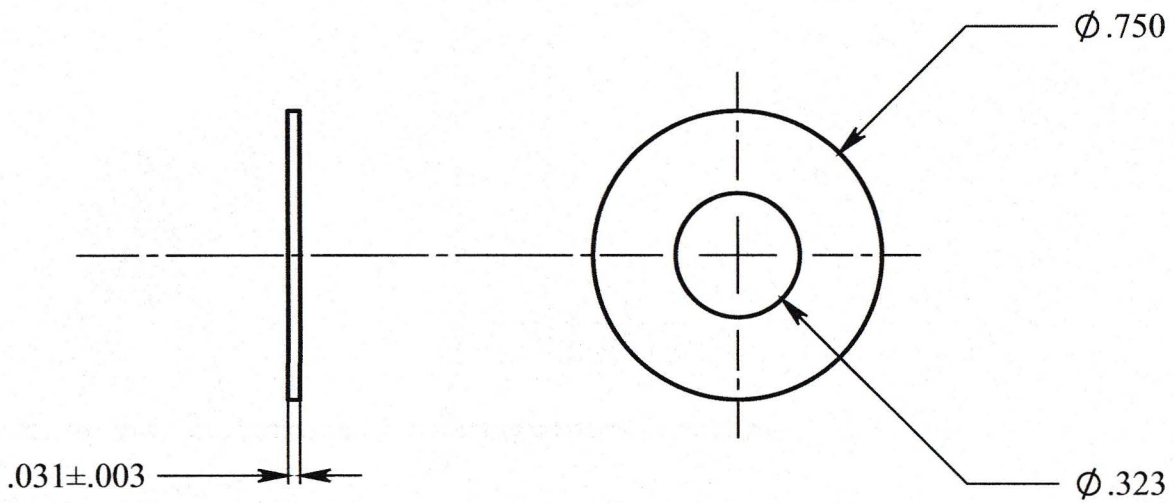
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

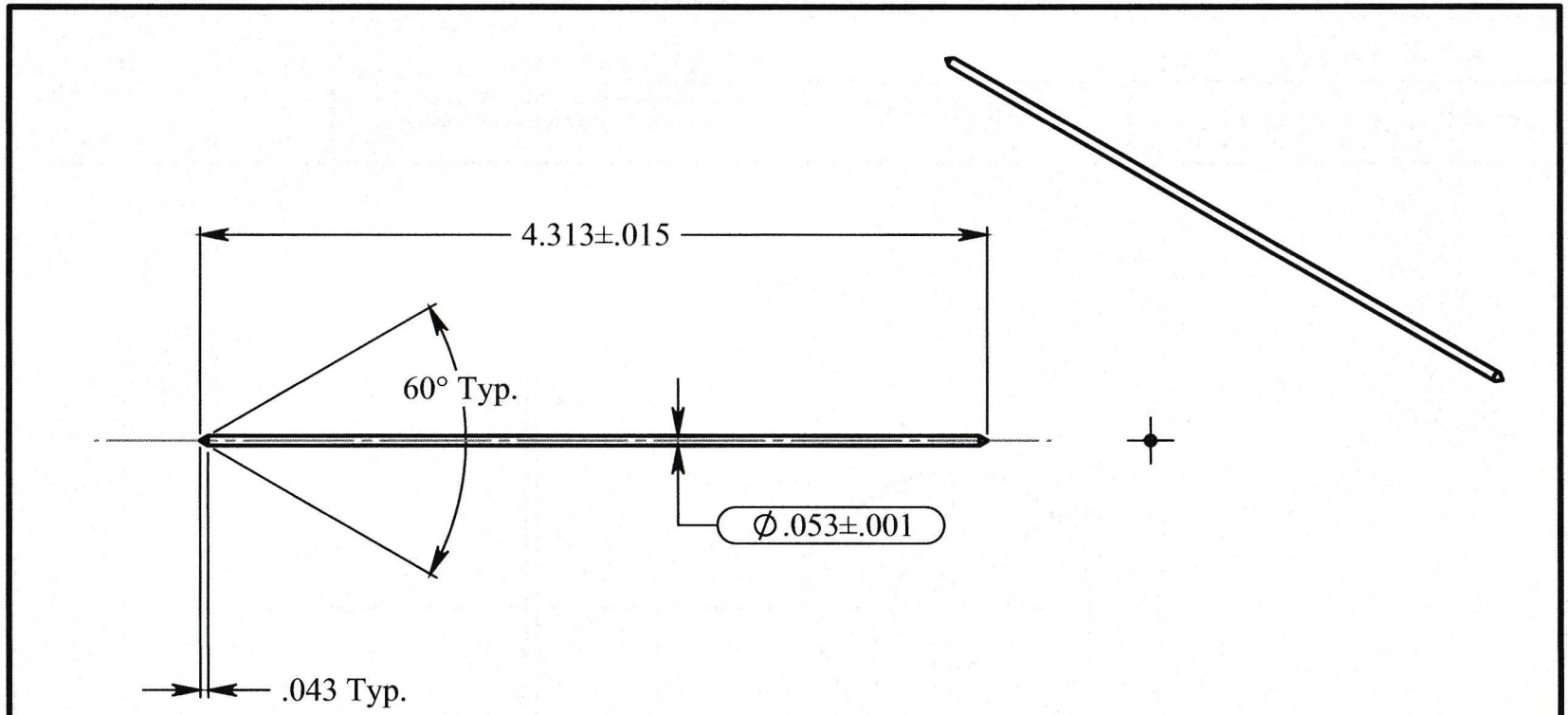
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

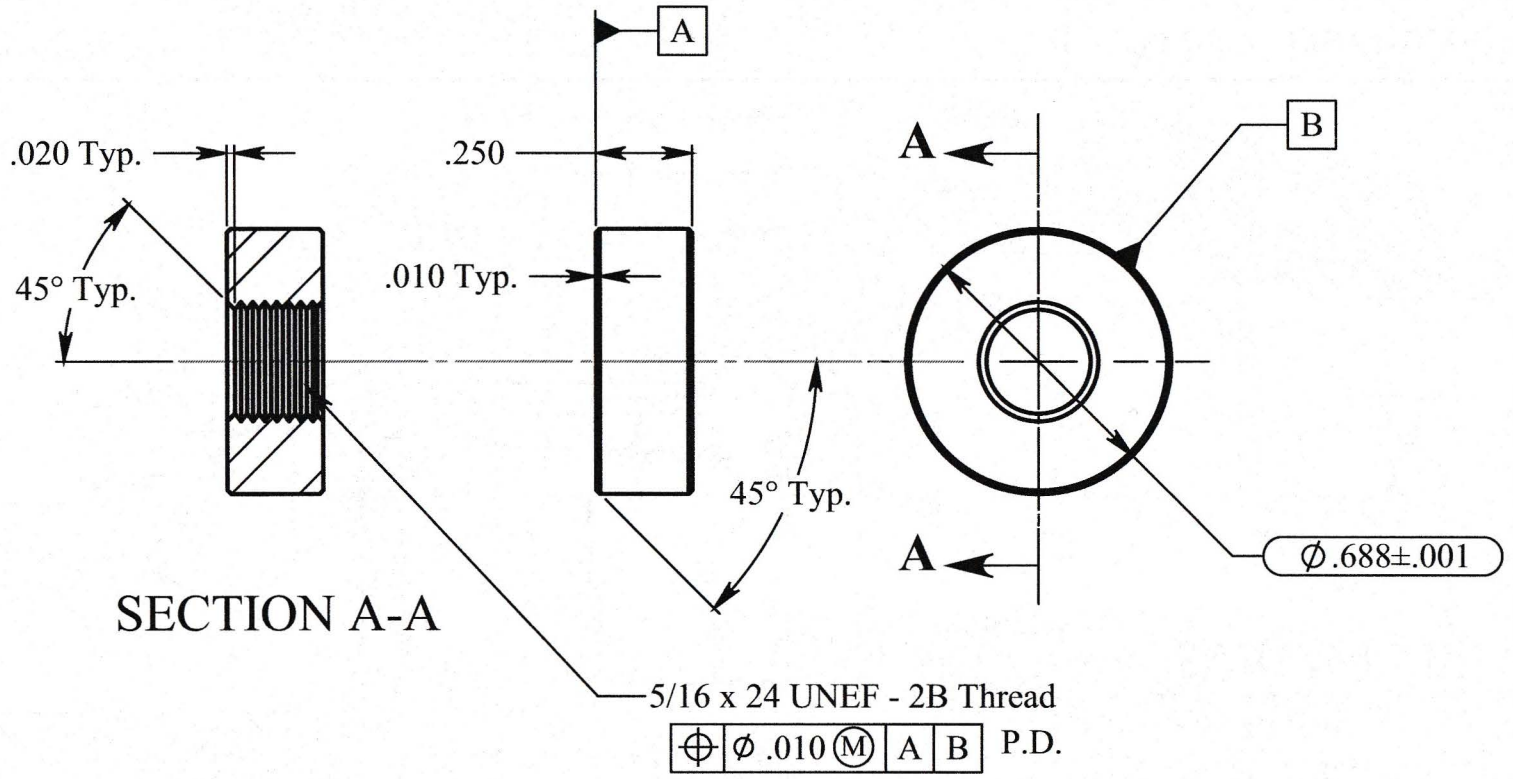
MATERIAL: AISI 1095	M1A1 Thompson
HEAT TREAT: Spring Temper	PART NAME: Oiler Door Spring
HARDNESS: HRA 74 - 77	OPERATION NAME:
FINISH: Black Oxide	OPERATION NO.: SCALE: 2:1



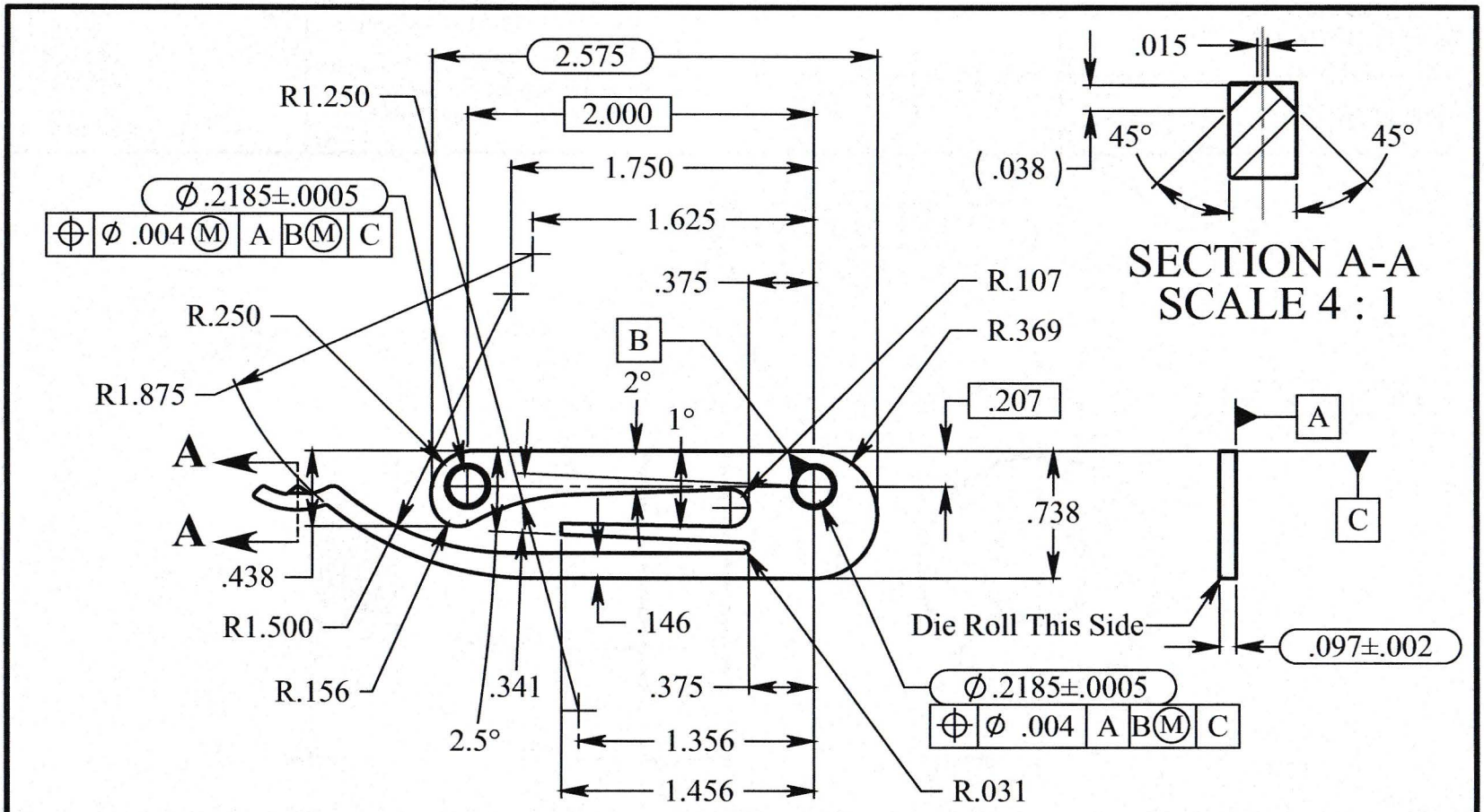
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL Neoprene Rubber	M1A1 Thompson	
		HEAT TREAT	PART NAME Oiler Gasket	
		HARDNESS 70 Durometer	OPERATION NAME	
		FINISH Black	OPERATION NO.	SCALE 2:1
	Proprietary and Confidential			



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 1095	M1A1 Thompson
		HEAT TREAT	PART NAME Oiler Stem
		HARDNESS	OPERATION NAME
		FINISH	OPERATION NO. / SCALE 1:1
	Proprietary and Confidential		



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL AISI 1215 HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME Oiler Threaded Insert OPERATION NAME OPERATION NO. SCALE 4:1



Dimensions are in Inches

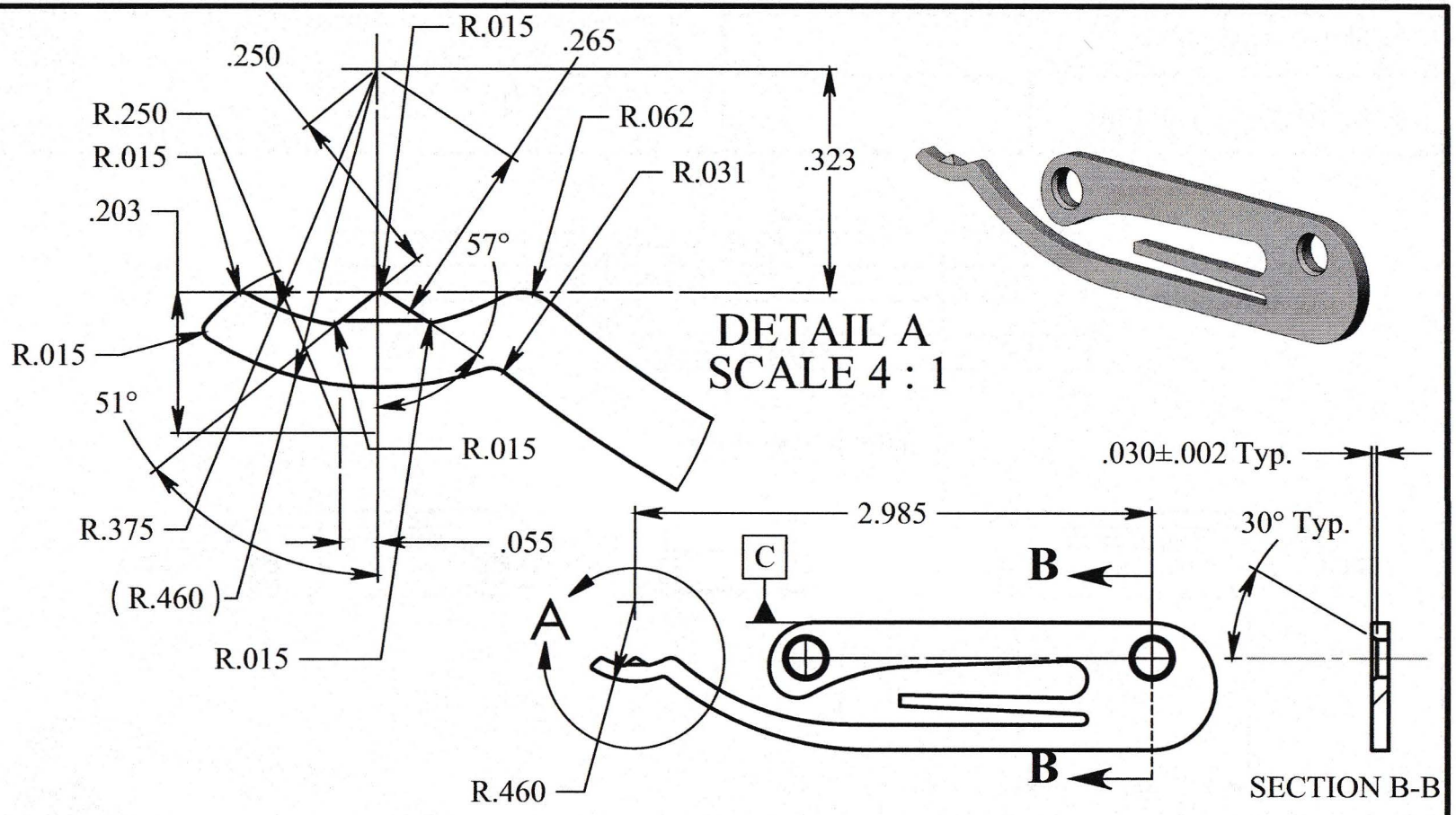
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

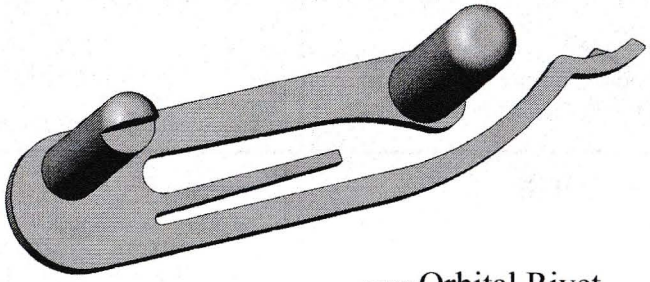
Proprietary and Confidential

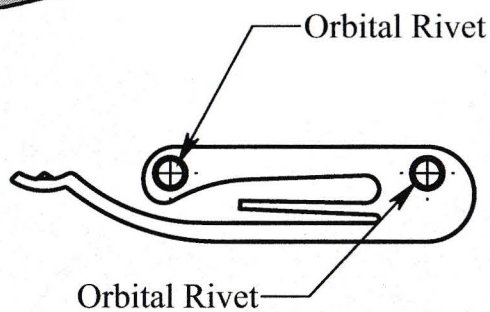
MATERIAL: AISI 1070	M1A1 Thompson
HEAT TREAT: Spring Temper	PART NAME: Pivot Plate - Sheet 1
HARDNESS: HRA 74 - 77	OPERATION NAME:
FINISH: None	OPERATION NO.: / SCALE: 1:1

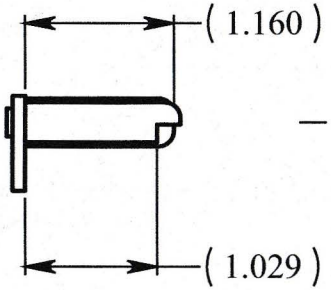
200

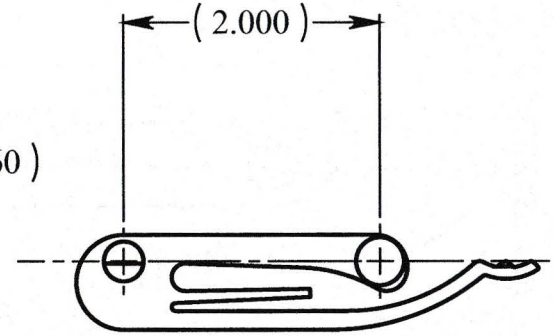


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)	MATERIAL: AISI 1070 HEAT TREAT: Spring Temper HARDNESS: HRA 74 - 77 FINISH: None	M1A1 Thompson PART NAME: Pivot Plate - Sheet 2 OPERATION NAME: OPERATION NO.: SCALE: 1:1
	Proprietary and Confidential		









ITEM NO.	PART NUMBER	QTY.
1	Pivot Plate	1
2	Pivot Plate Pin, Sear	1
3	Pivot Plate Pin, Trigger	1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH
Mag. Phosphate

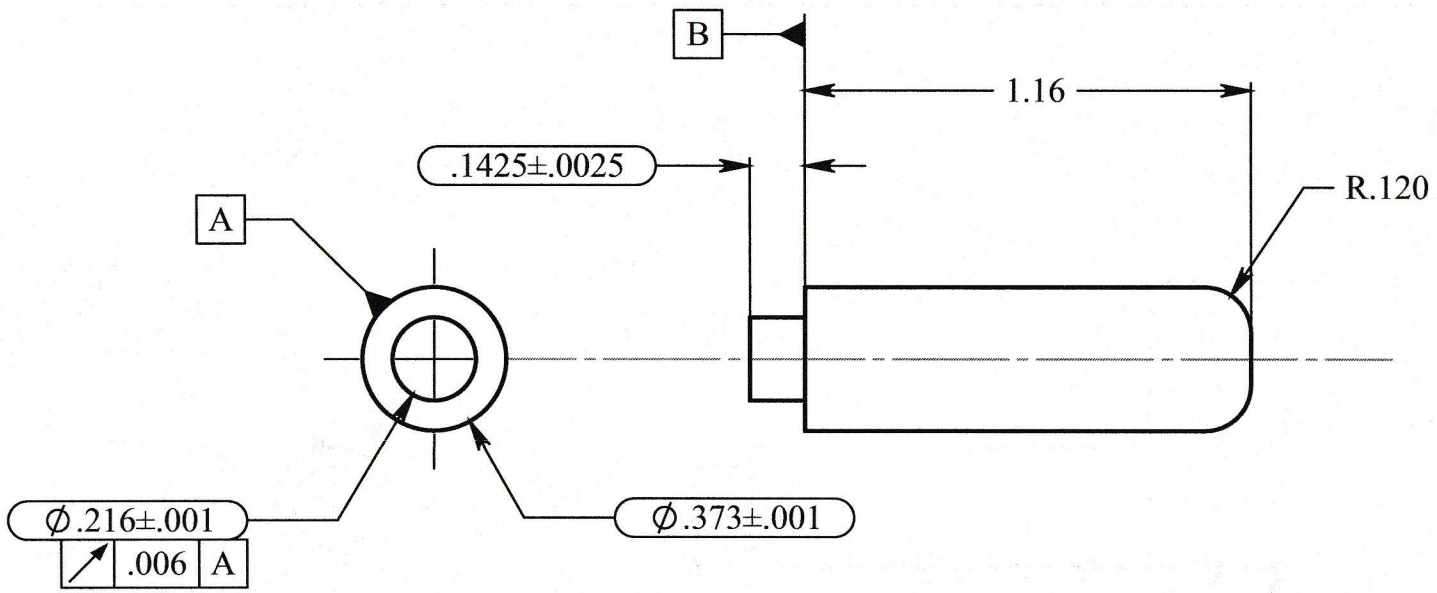
M1A1 Thompson

PART NAME
Pivot Plate Assembly

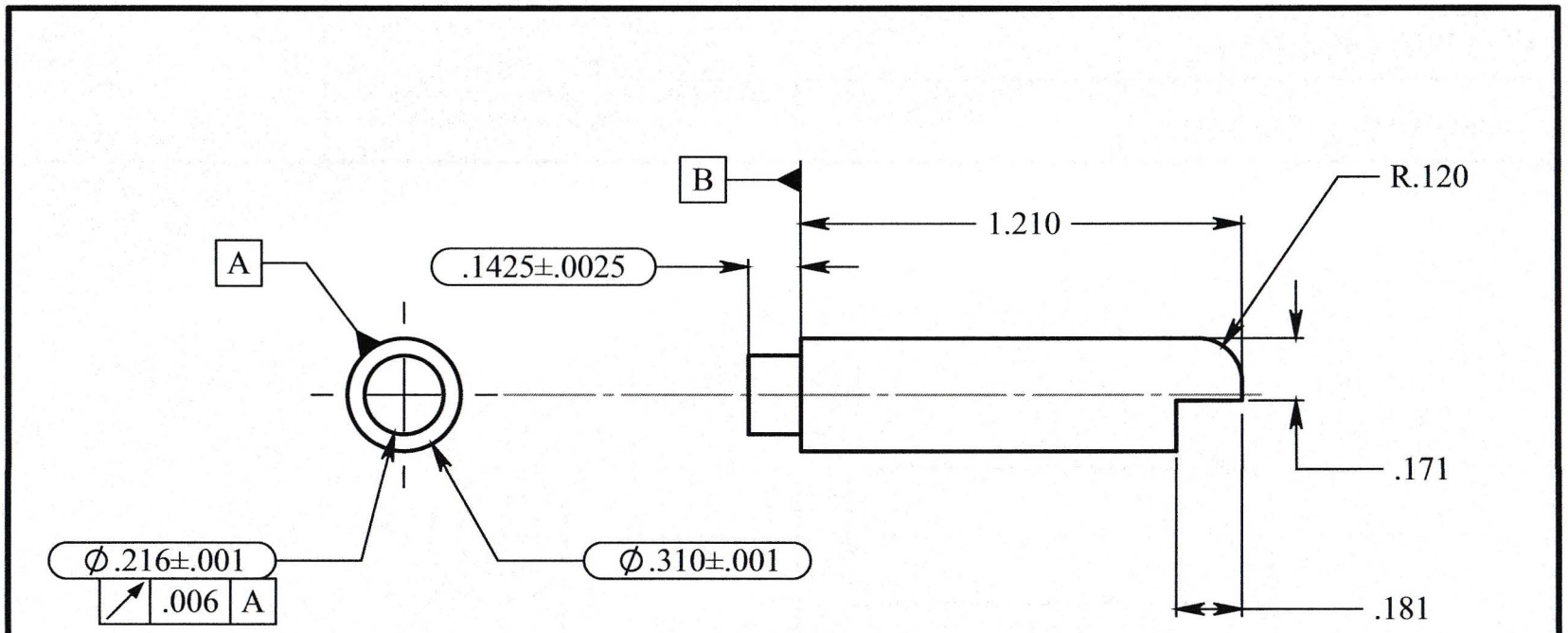
OPERATION NAME

OPERATION NO.

SCALE
2:3



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL: AISI 1215 HEAT TREAT: None HARDNESS: HRB 100 Min. FINISH: None	M1A1 Thompson PART NAME: Pivot Plate Pin, Sear OPERATION NAME: OPERATION NO.: SCALE: 2:1



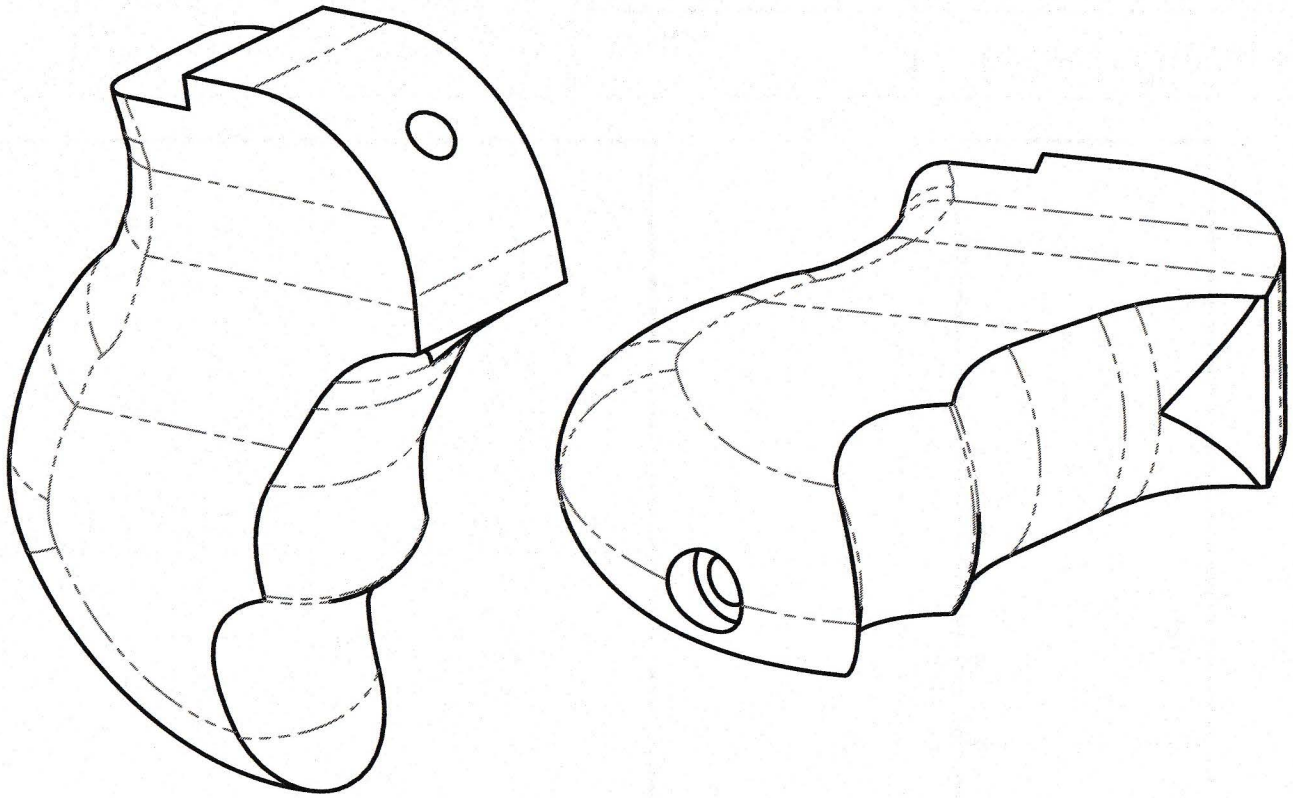
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

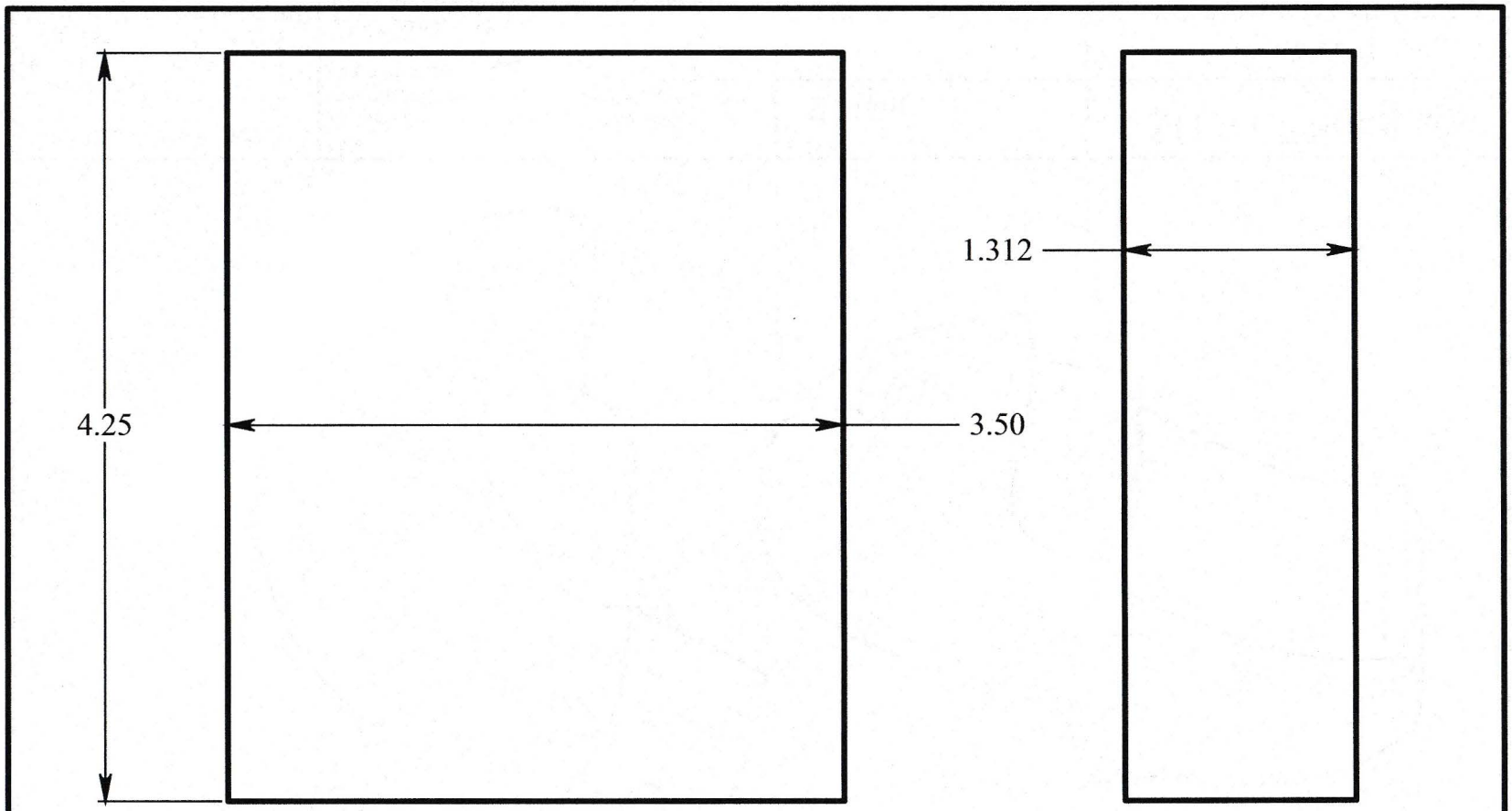
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1215	M1A1 Thompson
HEAT TREAT: None	PART NAME: Pivot Plate Pin, Trigger
HARDNESS: HRB 100 Min.	OPERATION NAME:
FINISH: None	OPERATION NO.: / SCALE: 2:1

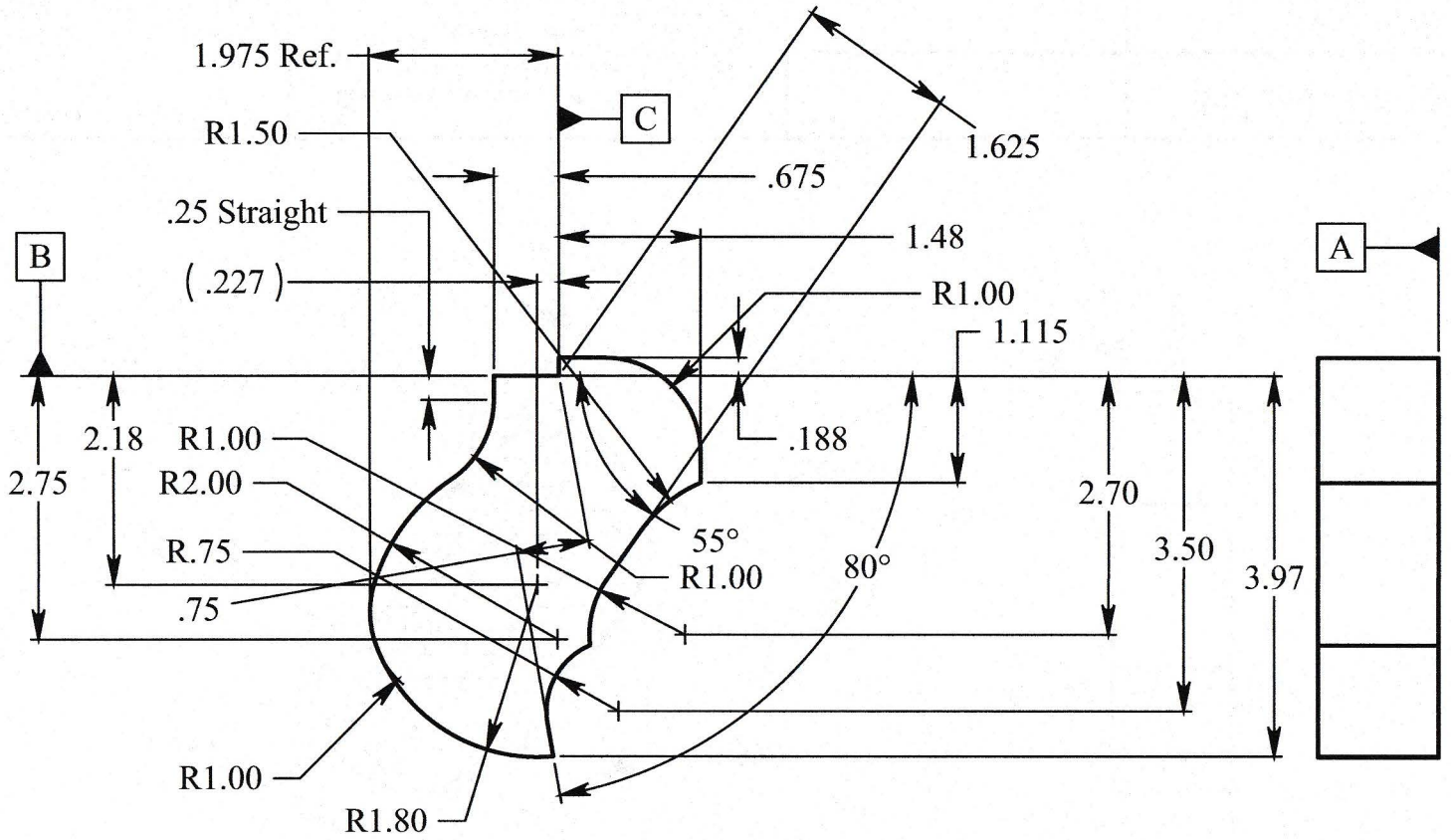


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX	MATERIAL: Walnut HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Rear Grip OPERATION NAME OPERATION NO. SCALE: 1:1
	Proprietary and Confidential		

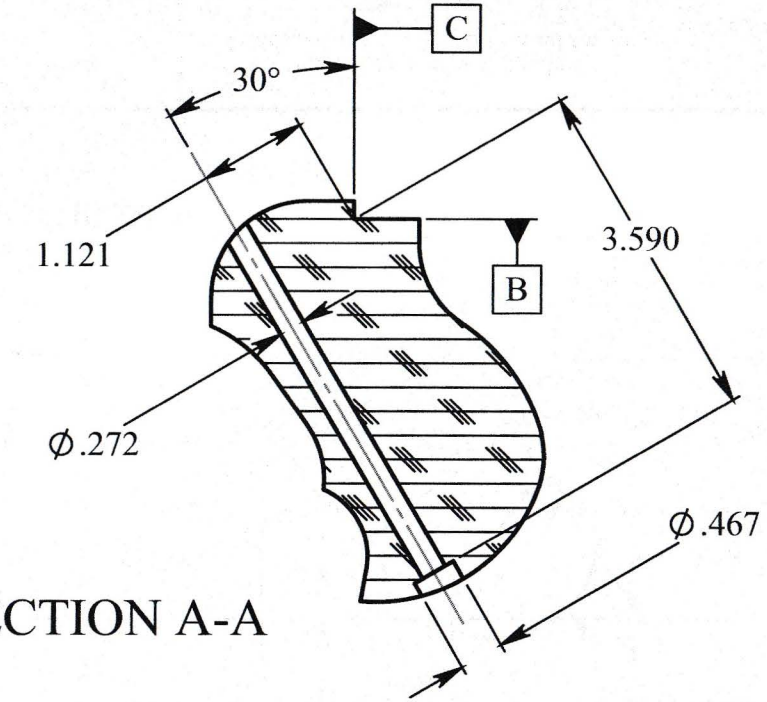


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX	MATERIAL Walnut	M1A1 Thompson
		HEAT TREAT	PART NAME Rear Grip
		HARDNESS	OPERATION NAME Blank
		FINISH	OPERATION NO. 10 / SCALE 1:1

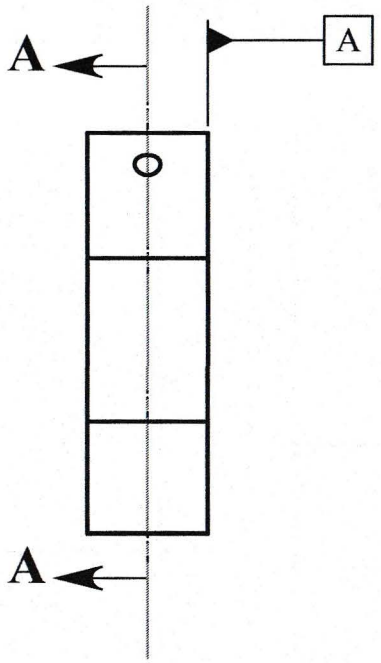
Proprietary and Confidential



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Rear Grip OPERATION NAME: Side Profile OPERATION NO.: 20 SCALE: 1:2



SECTION A-A



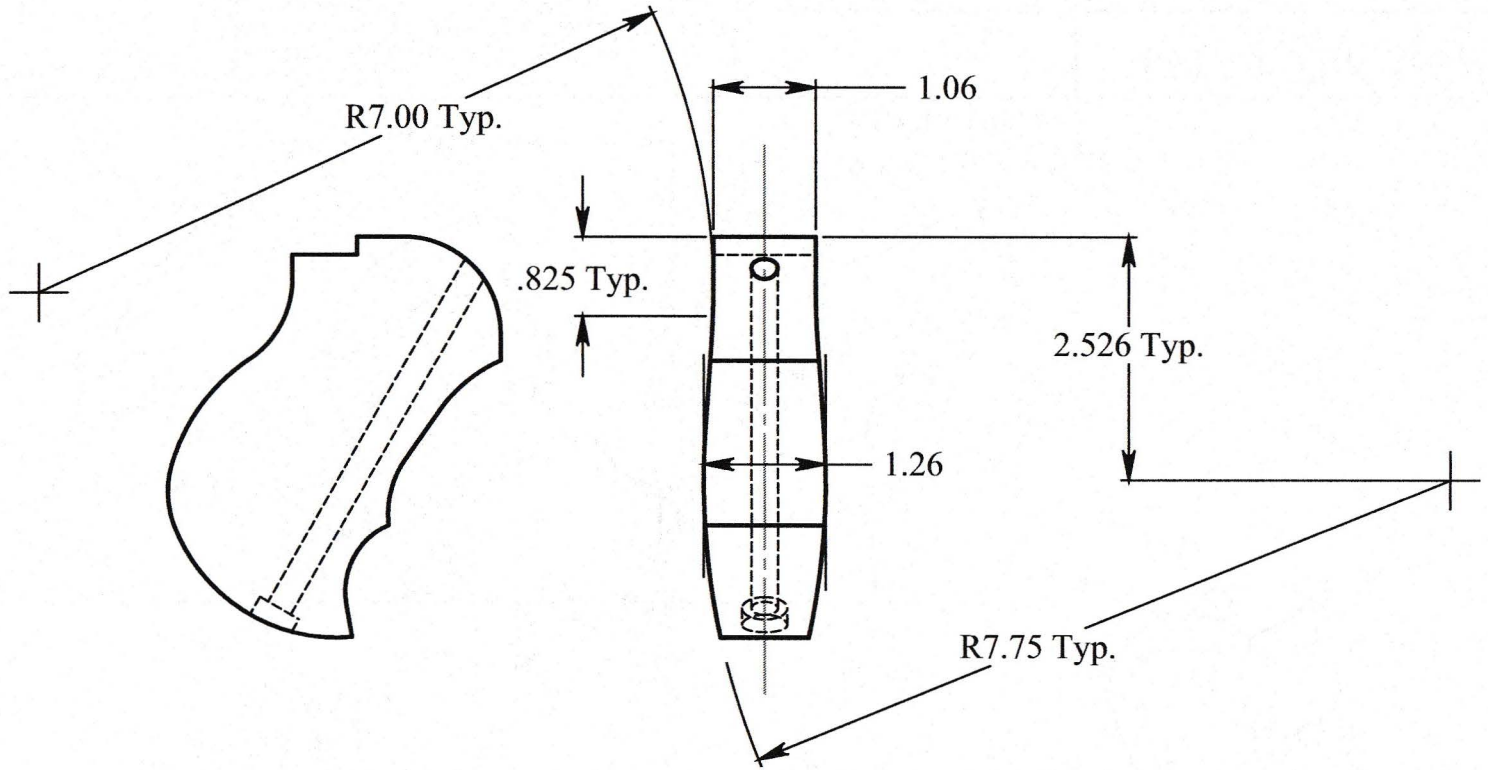
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

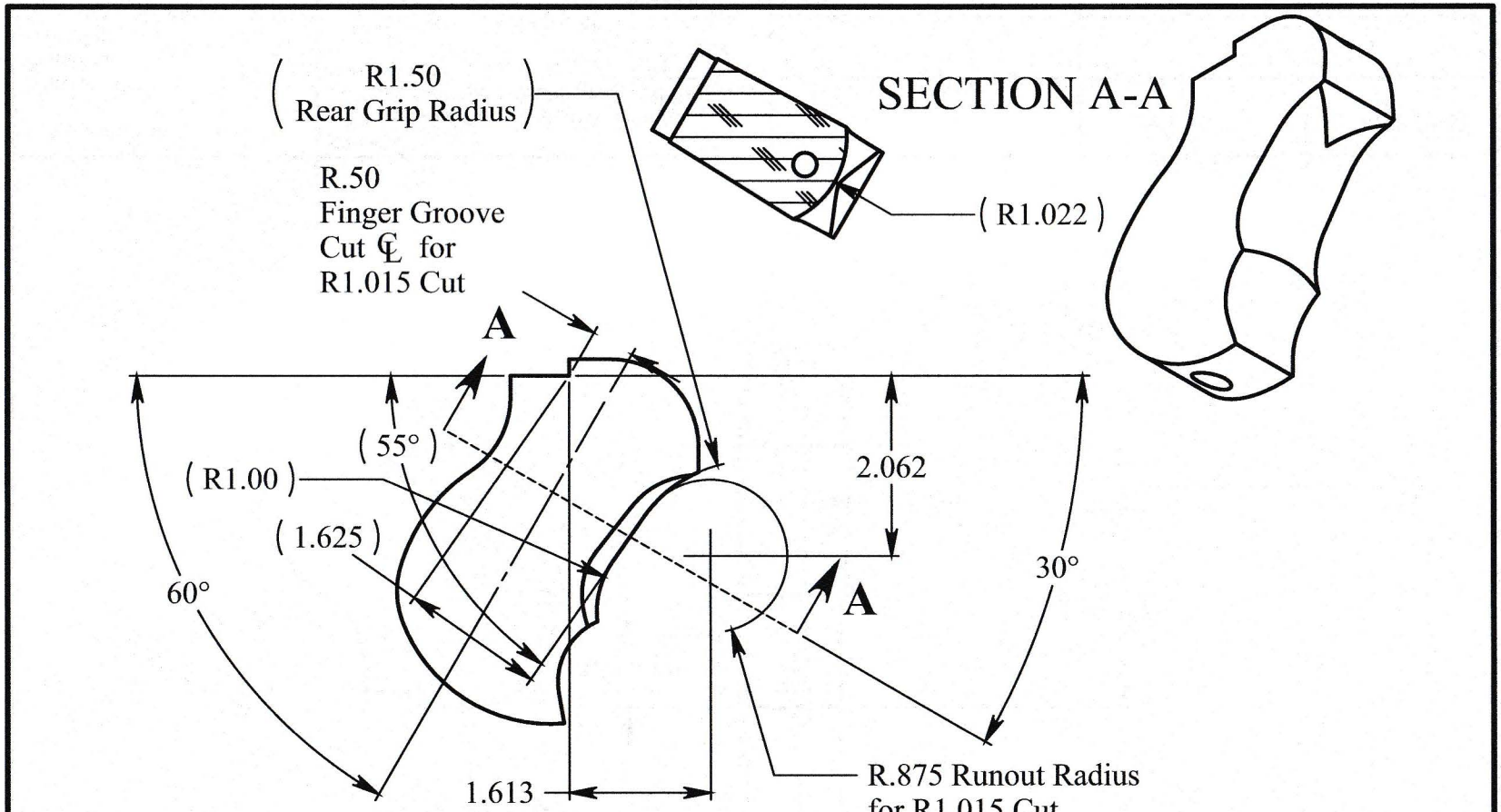
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Rear Grip
HARDNESS	OPERATION NAME: Mounting Hole
FINISH	OPERATION NO.: 30
	SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Rear Grip OPERATION NAME: End Profile OPERATION NO.: 40 SCALE: 1:2



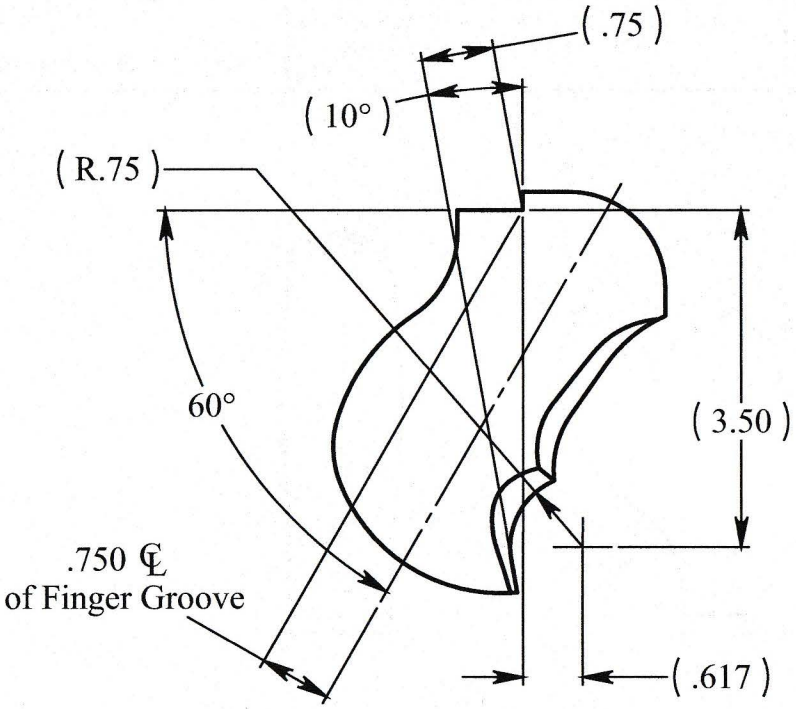
Dimensions are in Inches

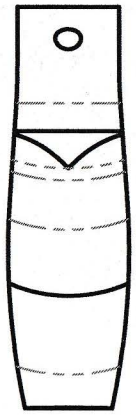
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

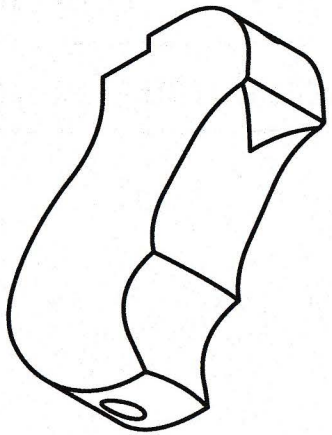
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

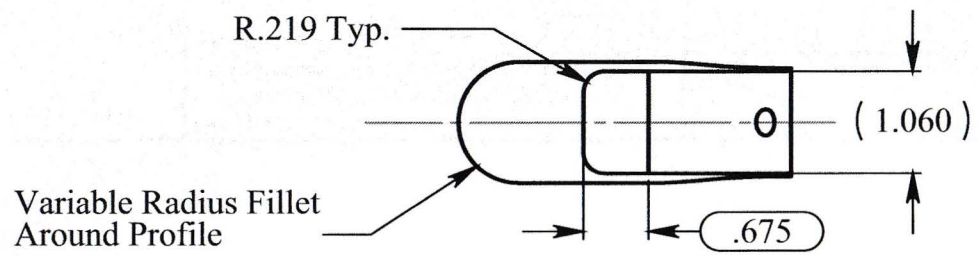
MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME Rear Grip
HARDNESS	OPERATION NAME Top Finger Groove
FINISH	OPERATION NO. 50 / SCALE 1:2

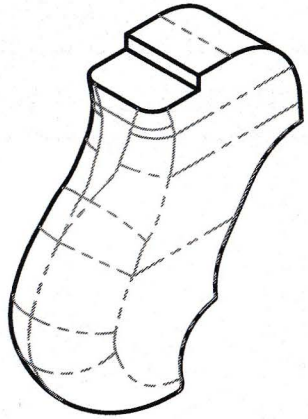


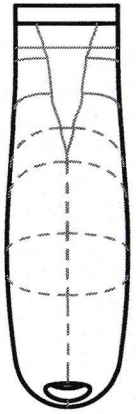


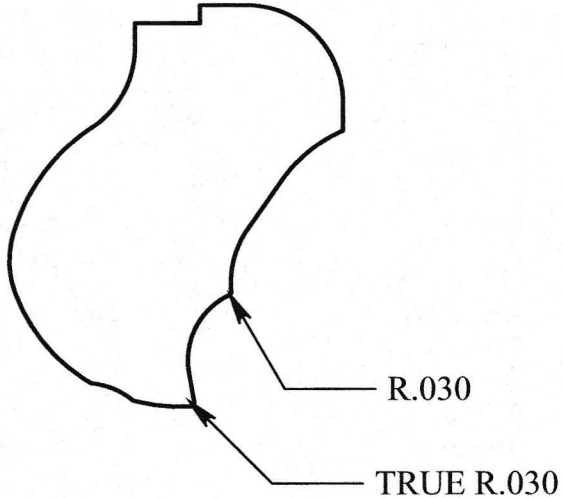


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Rear Grip
		HARDNESS	OPERATION NAME Bottom Finger Groove
	Proprietary and Confidential	FINISH	OPERATION NO. 60 / SCALE 1:2









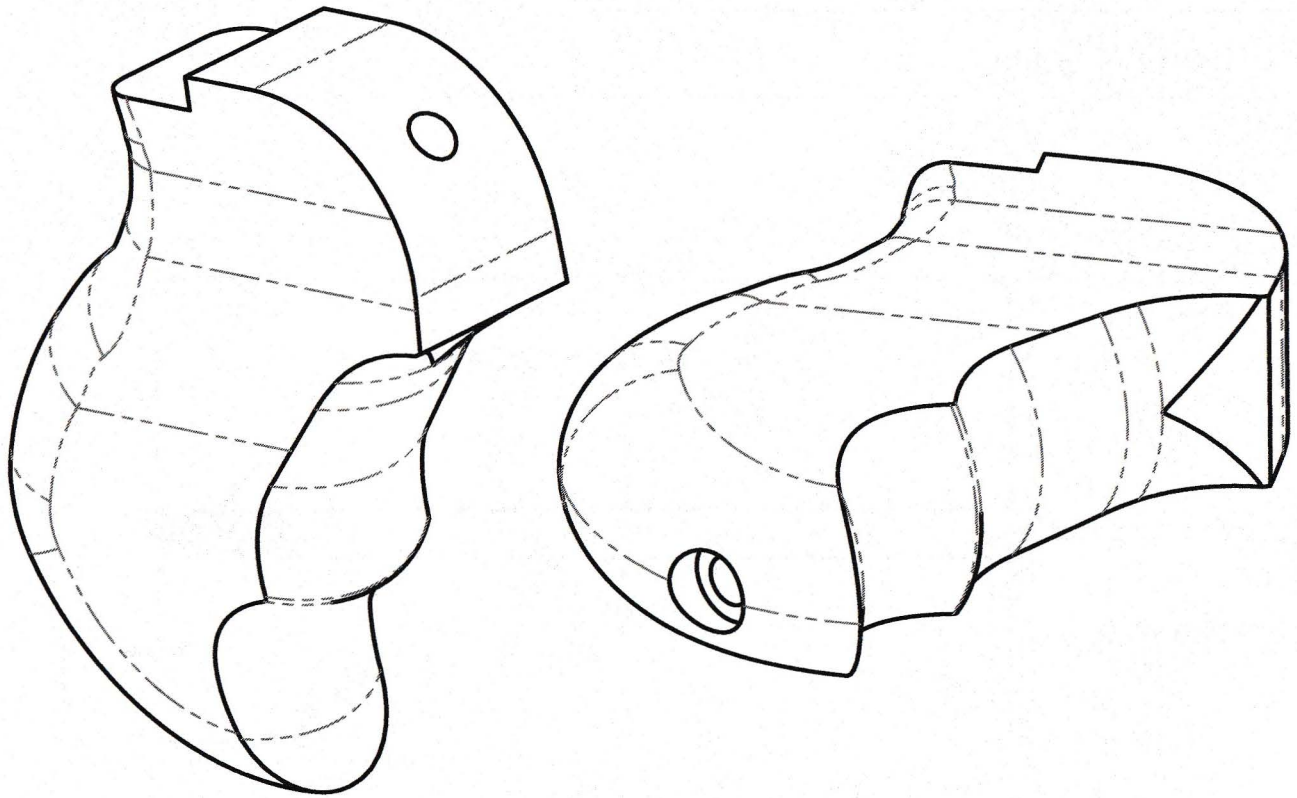
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

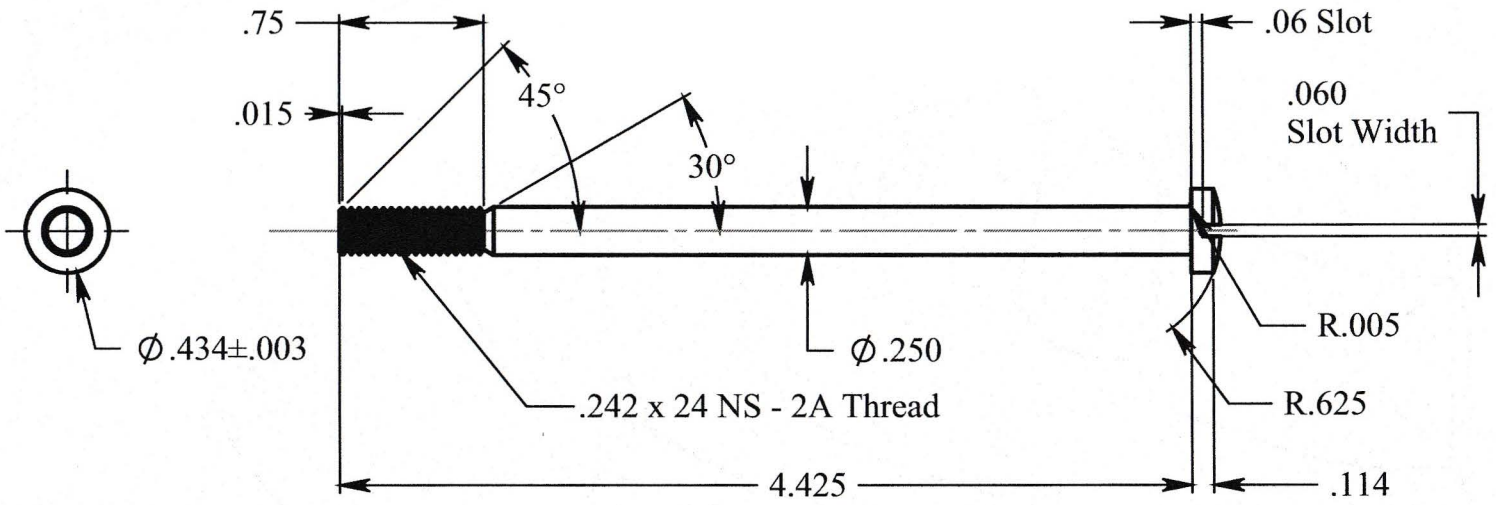
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Rear Grip
HARDNESS	OPERATION NAME: Back Radii - Sanding
FINISH	OPERATION NO.: 70
	SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL: Walnut HEAT TREAT: HARDNESS: FINISH: Stain and Oil	M1A1 Thompson PART NAME: Rear Grip OPERATION NAME: Finish OPERATION NO.: 80 SCALE: 1:1



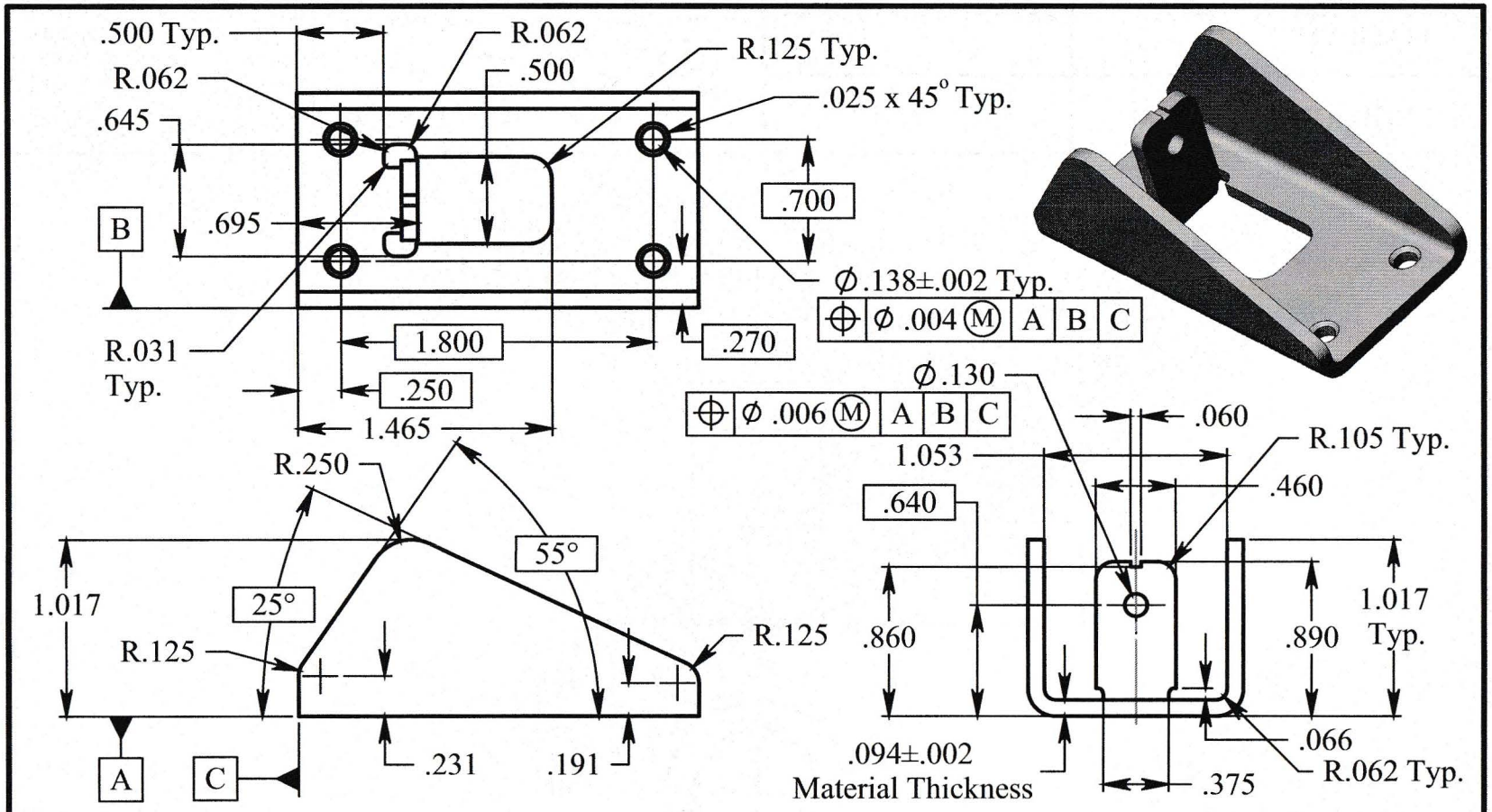
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

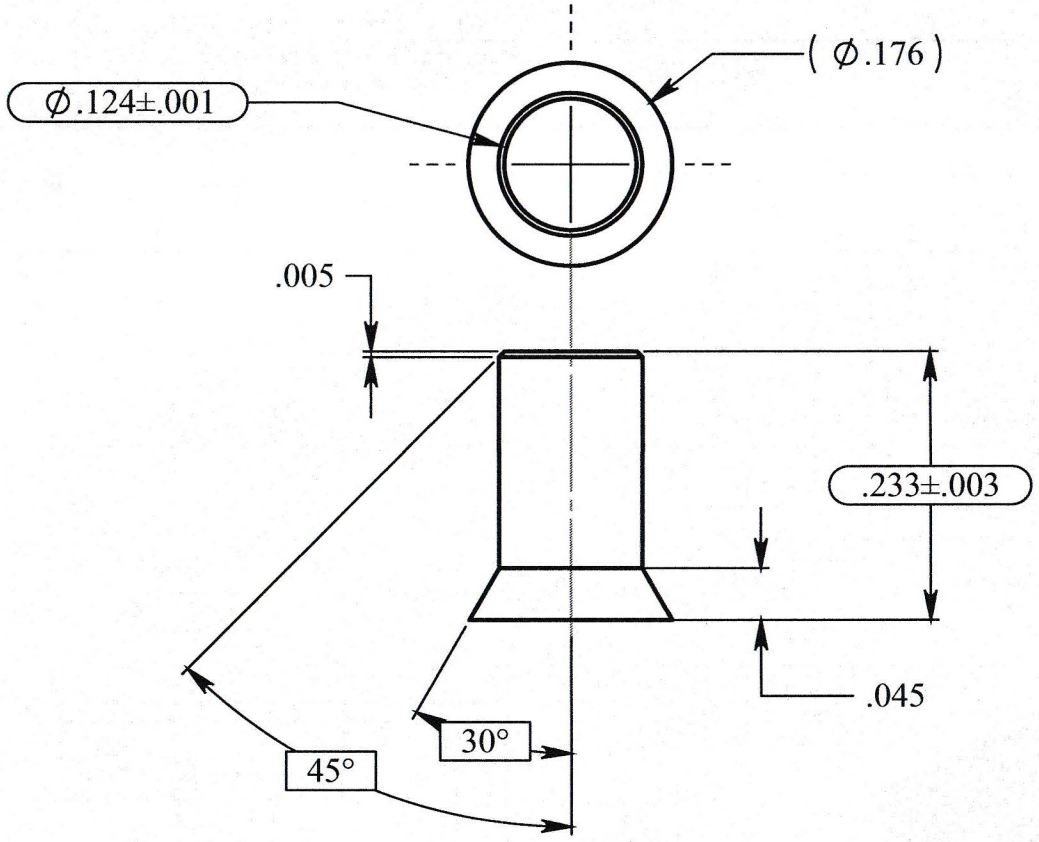
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1212	M1A1 Thompson
HEAT TREAT: Carburize .70% C	PART NAME: Rear Grip Ret. Screw
HARDNESS: HR15N 88 - 92	OPERATION NAME:
FINISH: Black Oxide	OPERATION NO.: / SCALE: 1:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 1010	M1A1 Thompson	
		HEAT TREAT None	PART NAME Rear Sight	
		HARDNESS HRB 100 Min.	OPERATION NAME	
		FINISH Mag. Phosphate	OPERATION NO.	SCALE 1:1
	Proprietary and Confidential			



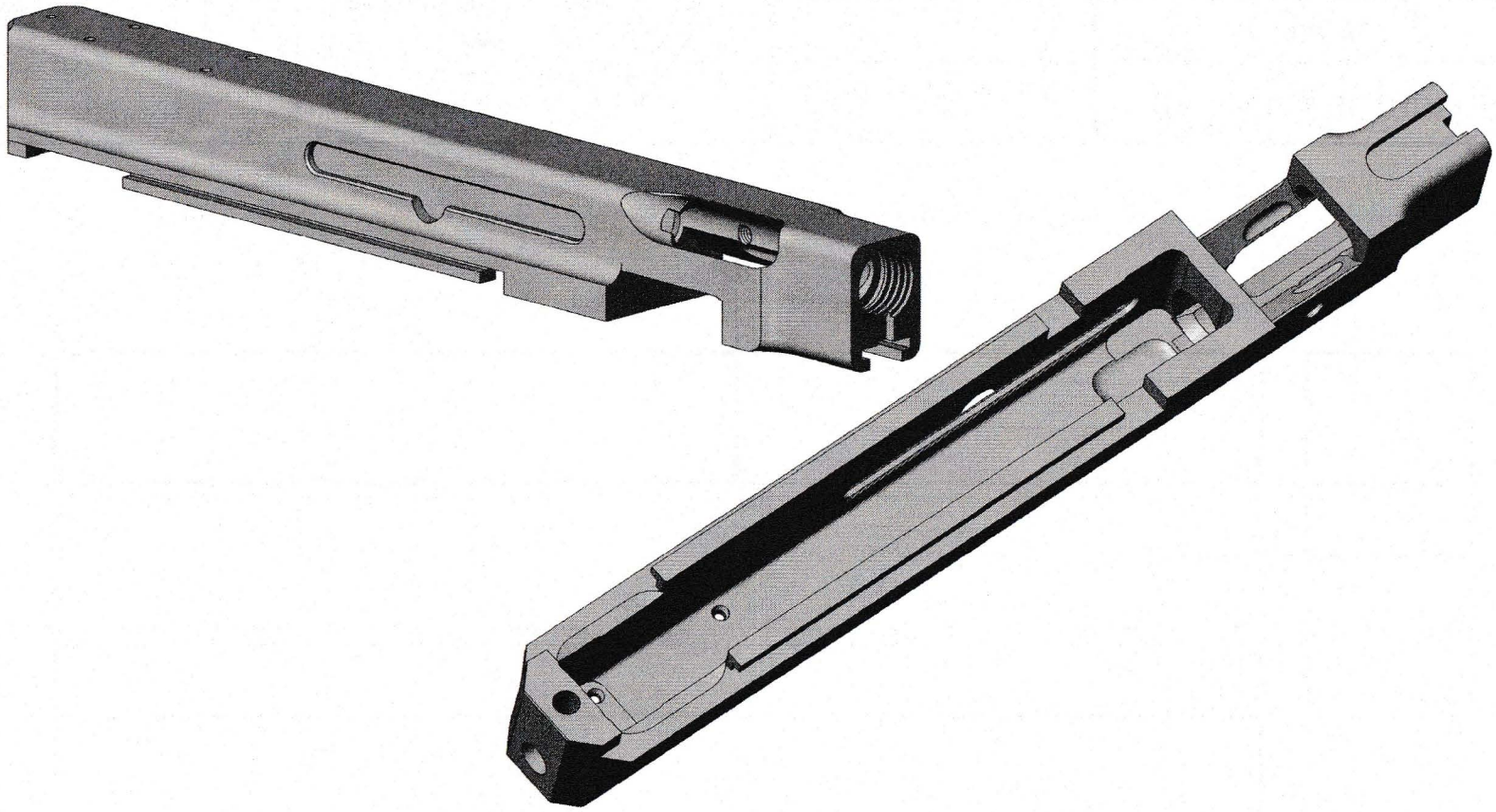
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

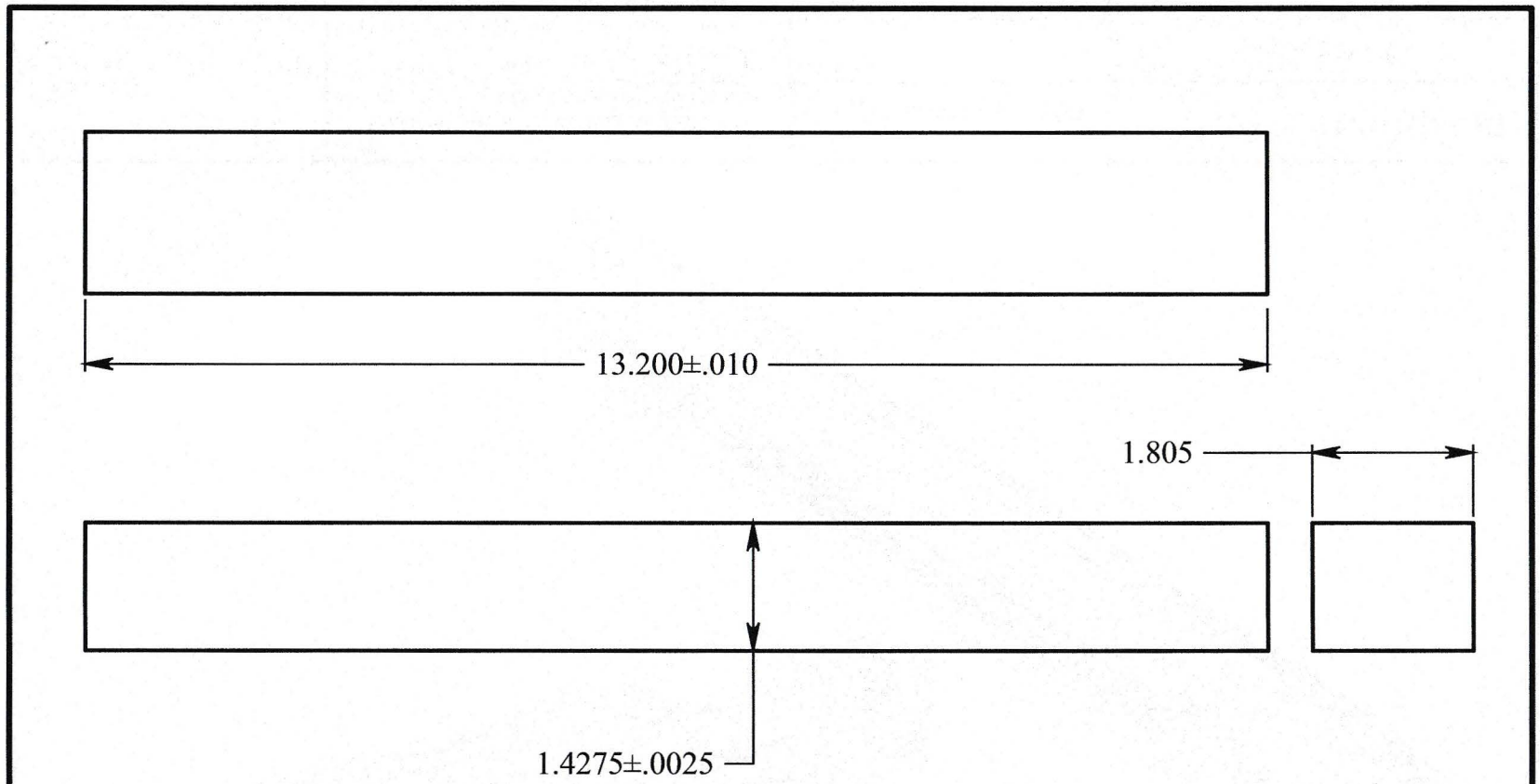
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1215	M1A1 Thompson
HEAT TREAT: None	PART NAME: Rear Sight Rivet
HARDNESS: HRB 100 Min.	OPERATION NAME:
FINISH: None	OPERATION NO.: / SCALE: 6:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX	MATERIAL AISI 1050 or 1340	M1A1 Thompson	
		HEAT TREAT	PART NAME Receiver	
		HARDNESS	OPERATION NAME	
		FINISH	OPERATION NO.	SCALE 1:2
	Proprietary and Confidential			



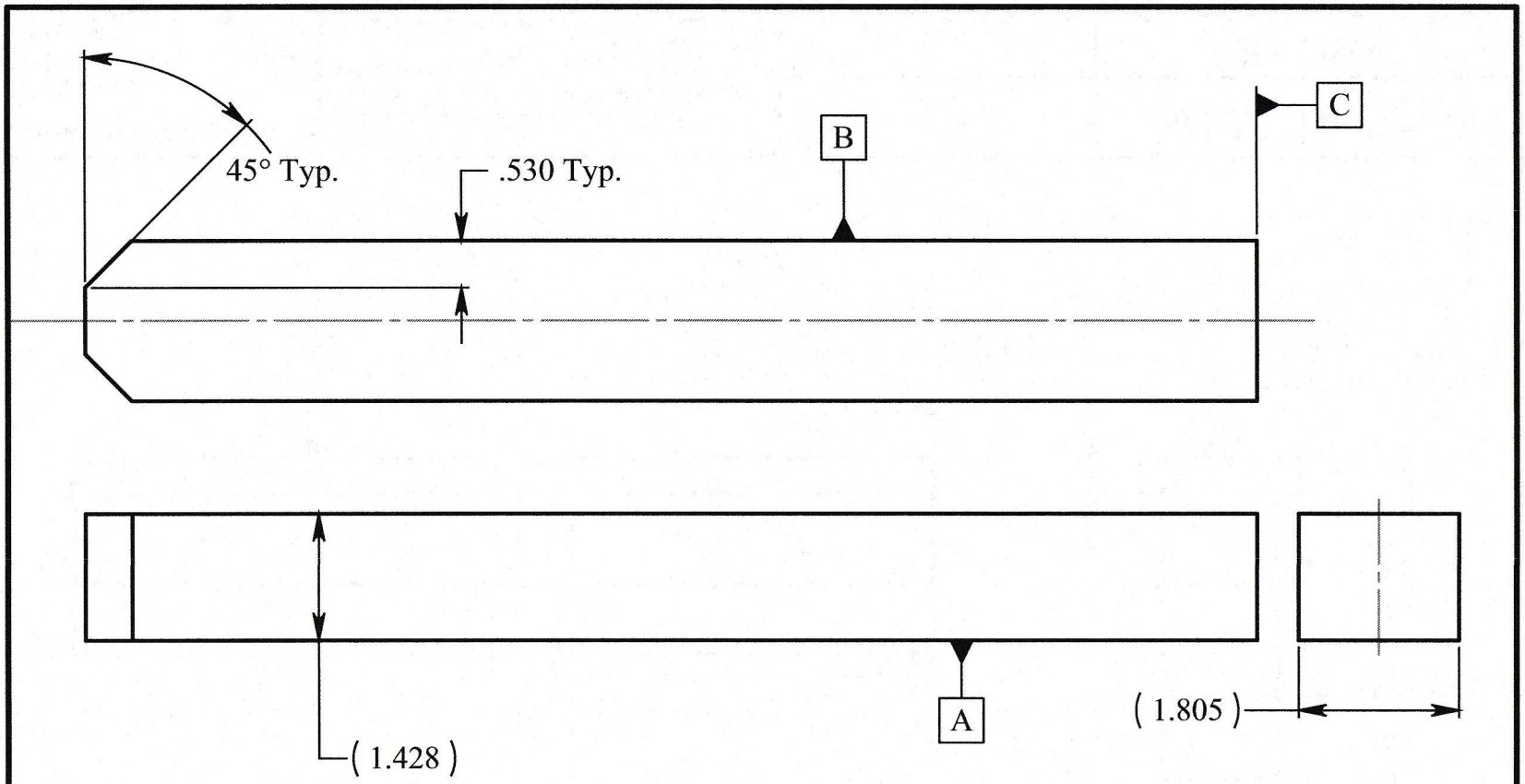
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

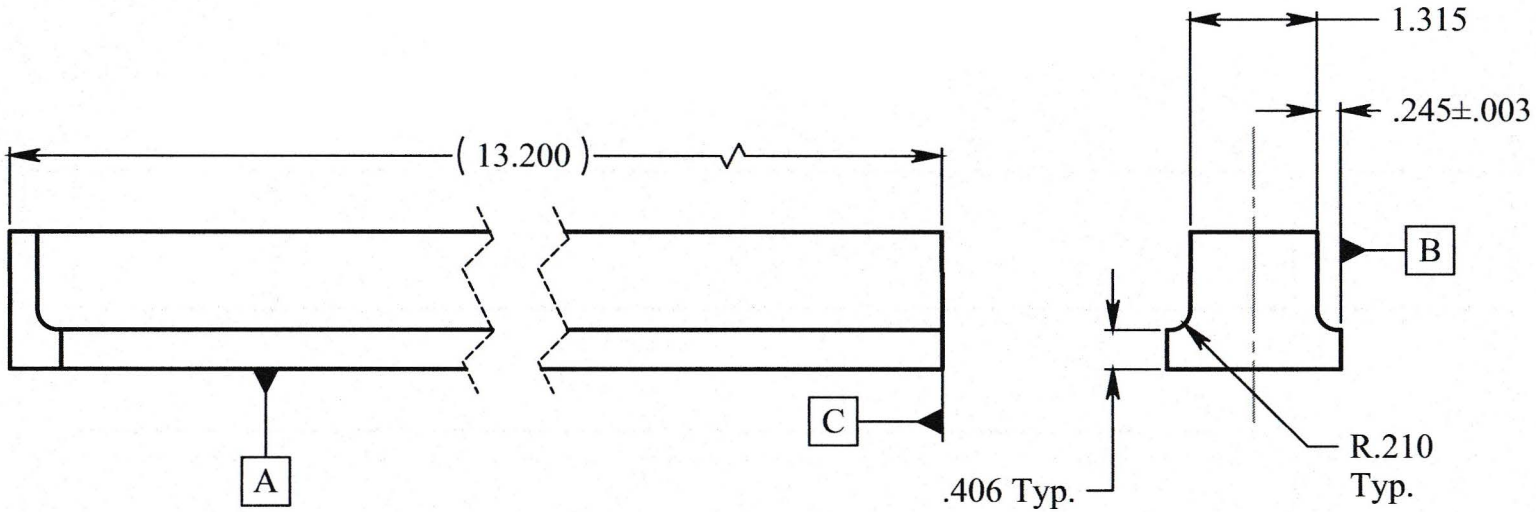
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX

Proprietary and Confidential

MATERIAL: AISI 1050 or 1340	M1A1 Thompson
HEAT TREAT	PART NAME: Receiver
HARDNESS	OPERATION NAME: Receiver Blank
FINISH	OPERATION NO.: 10 / SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX) Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Receiver OPERATION NAME: Rear Chamfers OPERATION NO.: 20 SCALE: 1:2



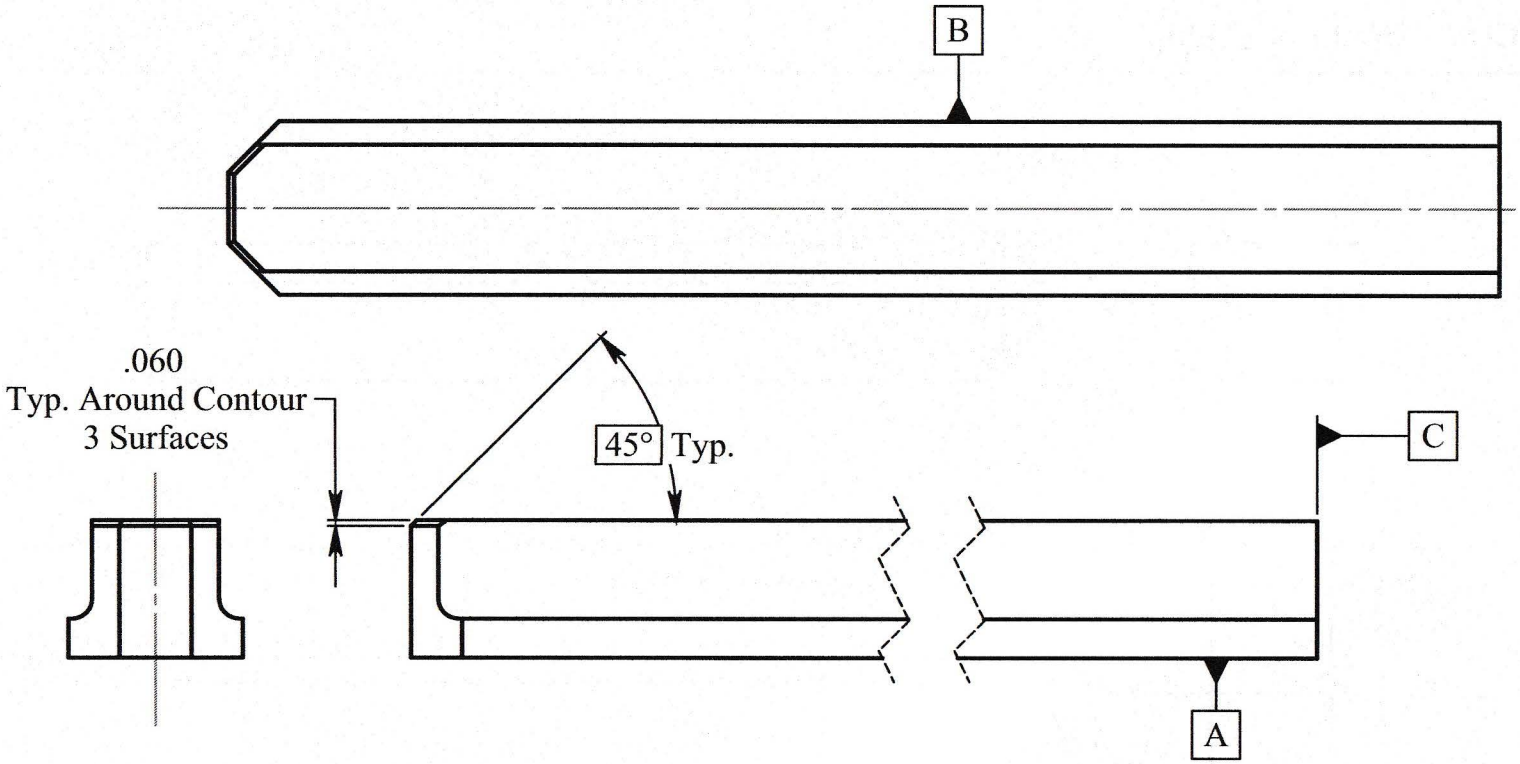
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

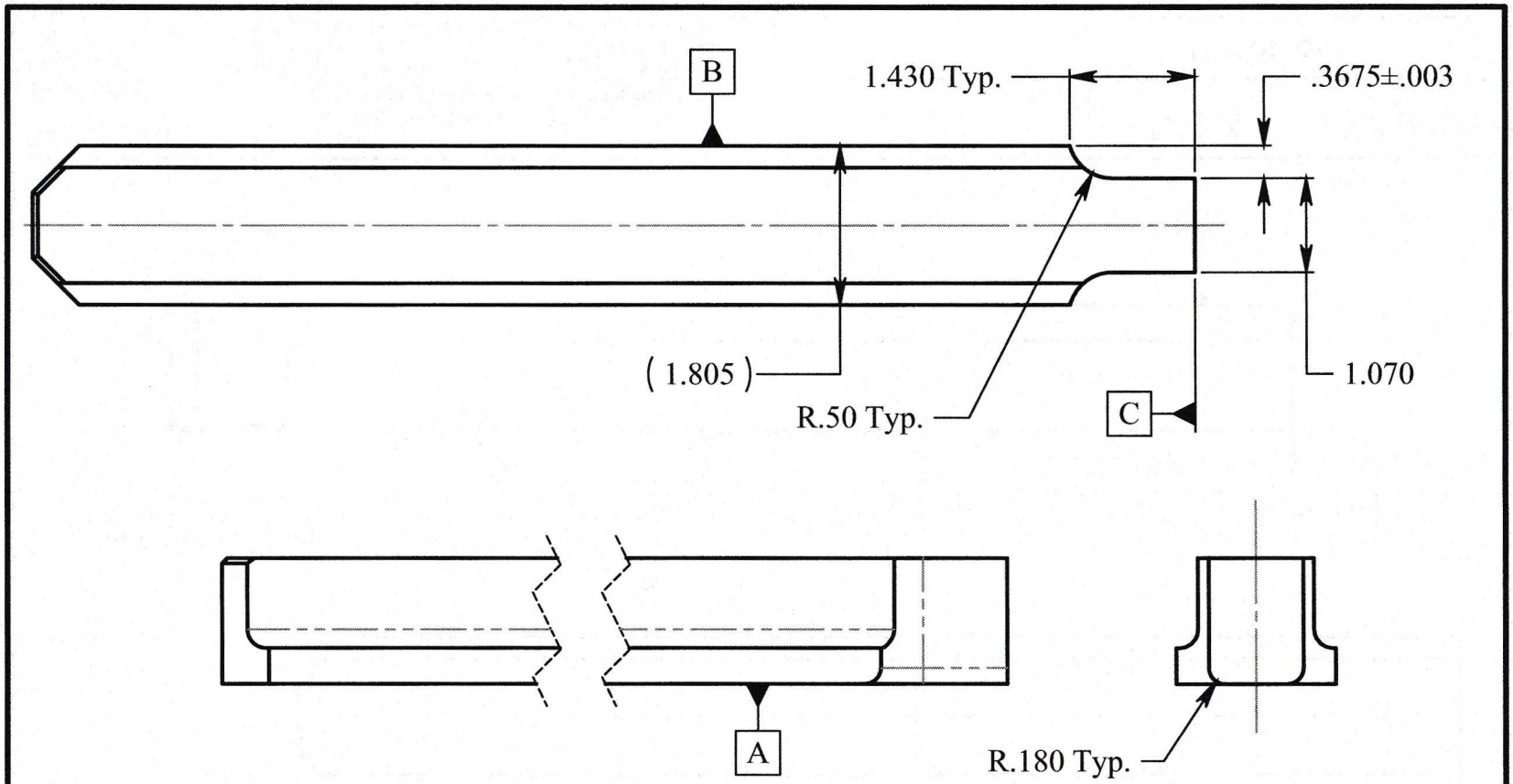
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Receiver
HARDNESS	OPERATION NAME: End Profile
FINISH	OPERATION NO.: 30
	SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME Receiver OPERATION NAME Rear Top Chamfer OPERATION NO. 40 SCALE 1:2



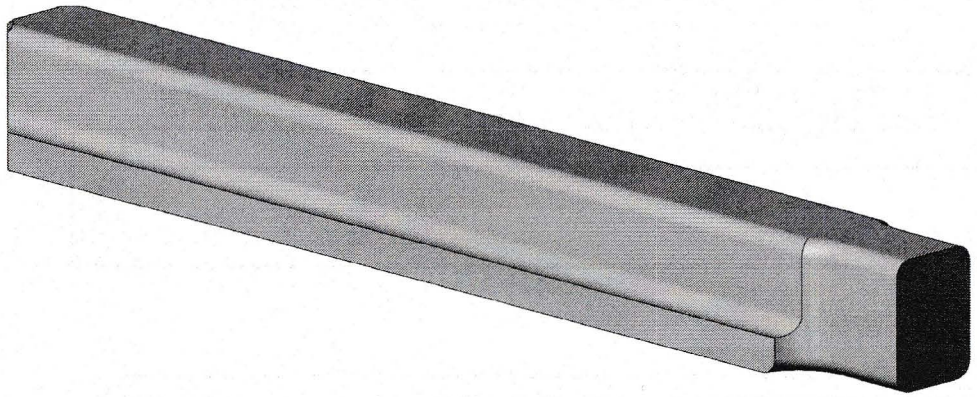
Dimensions are in Inches

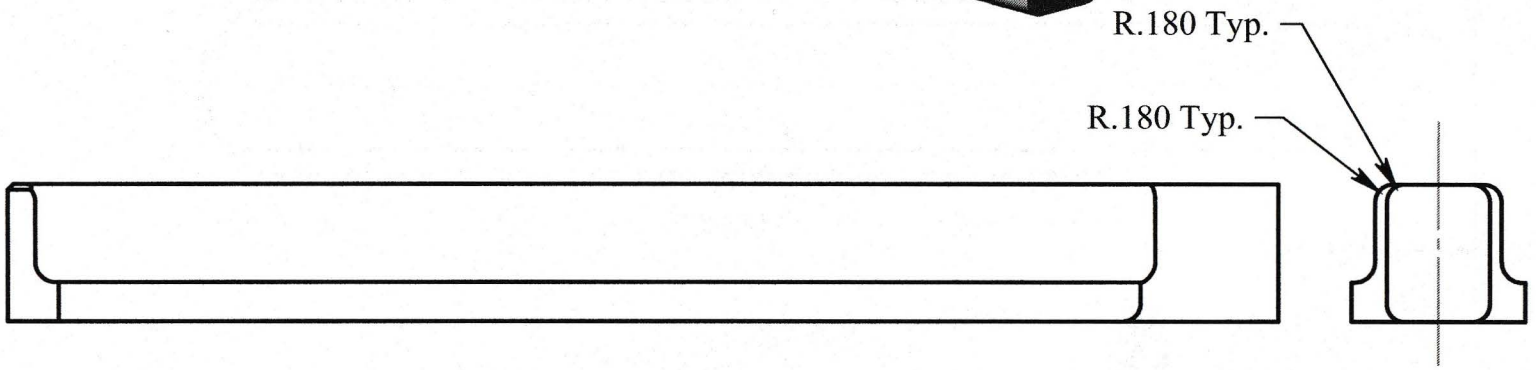
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

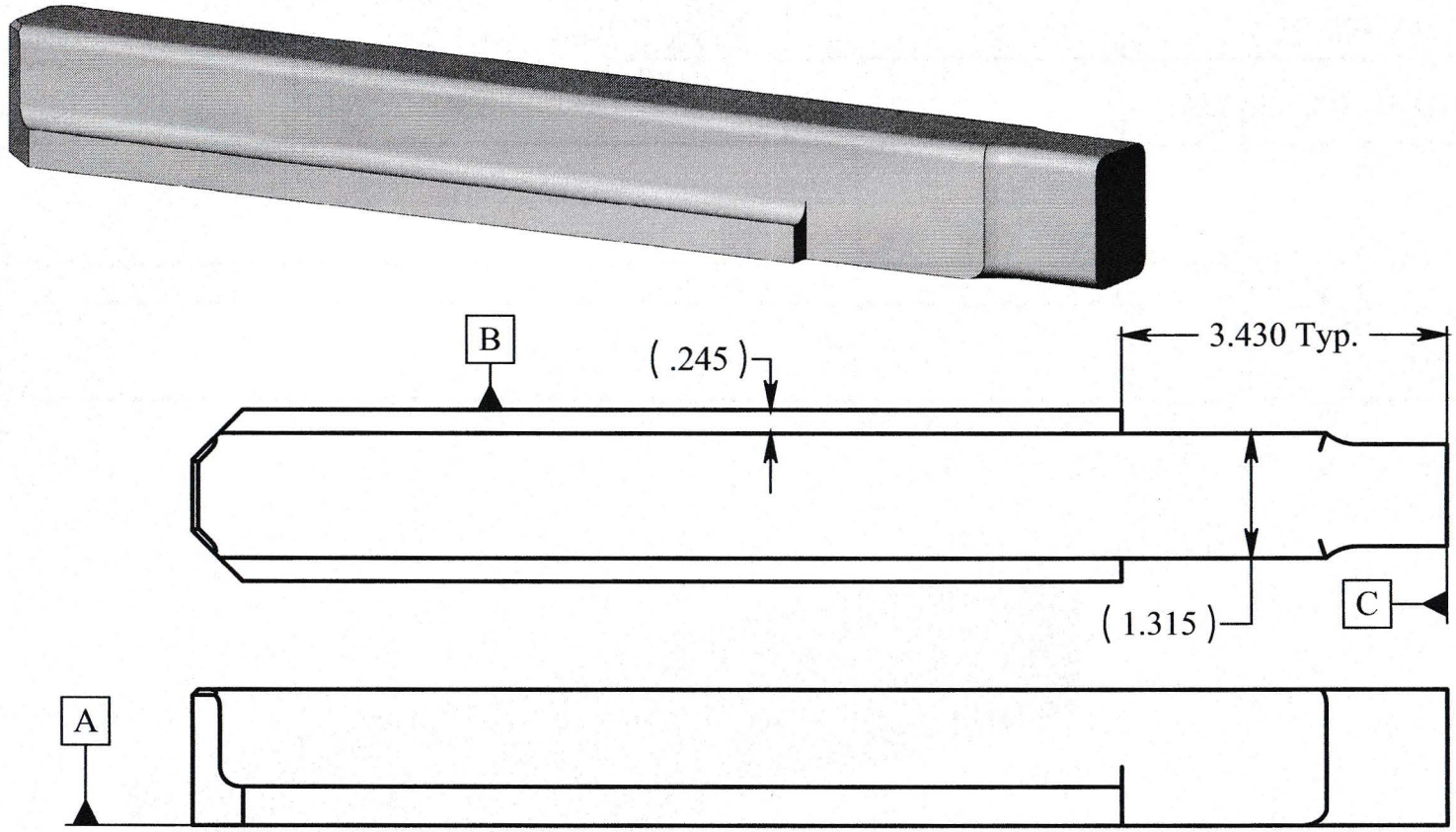
Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Receiver
HARDNESS	OPERATION NAME: Front Cut
FINISH	OPERATION NO.: 50
	SCALE: 1:2





Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME: Receiver
		HARDNESS	OPERATION NAME: Top Radii
		FINISH	OPERATION NO.: 60 — SCALE: 1:2
	Proprietary and Confidential		



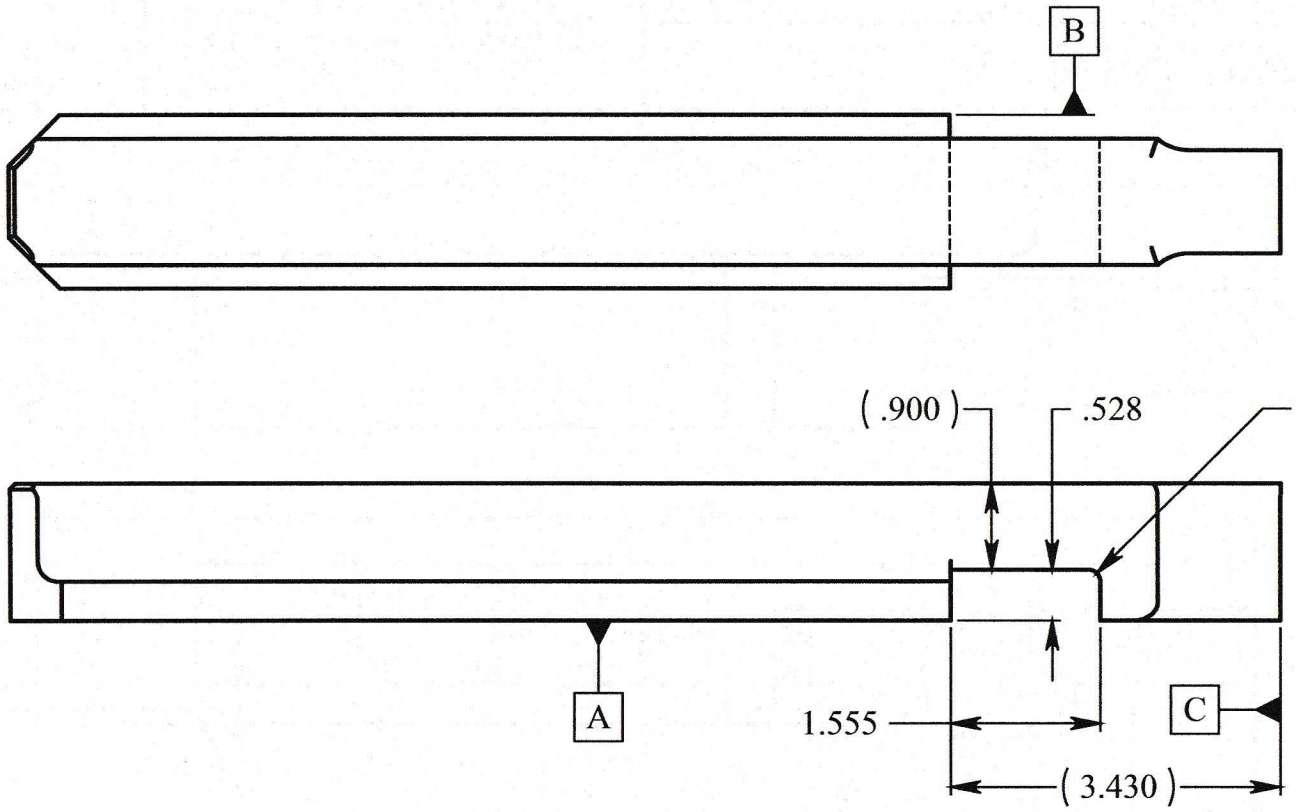
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

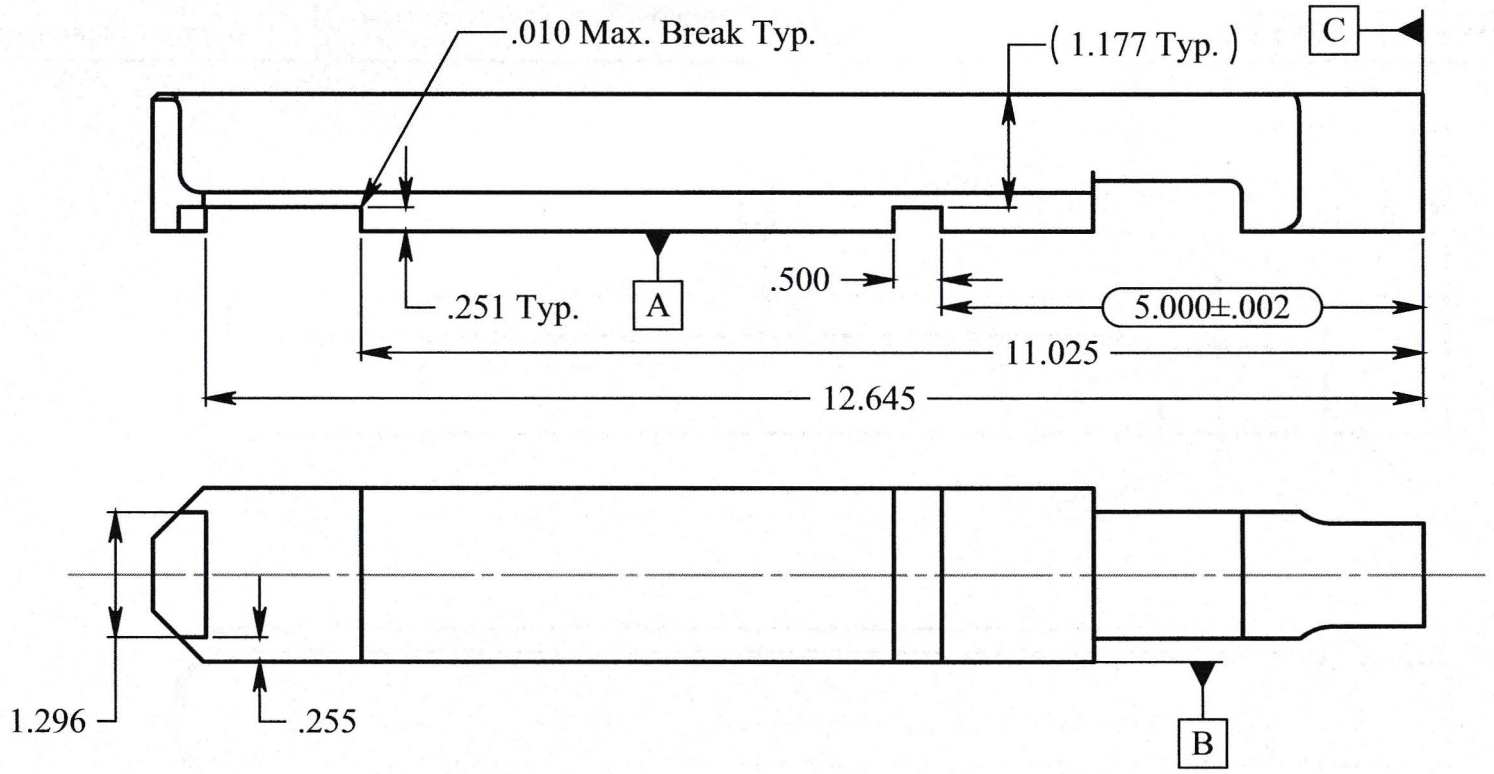
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

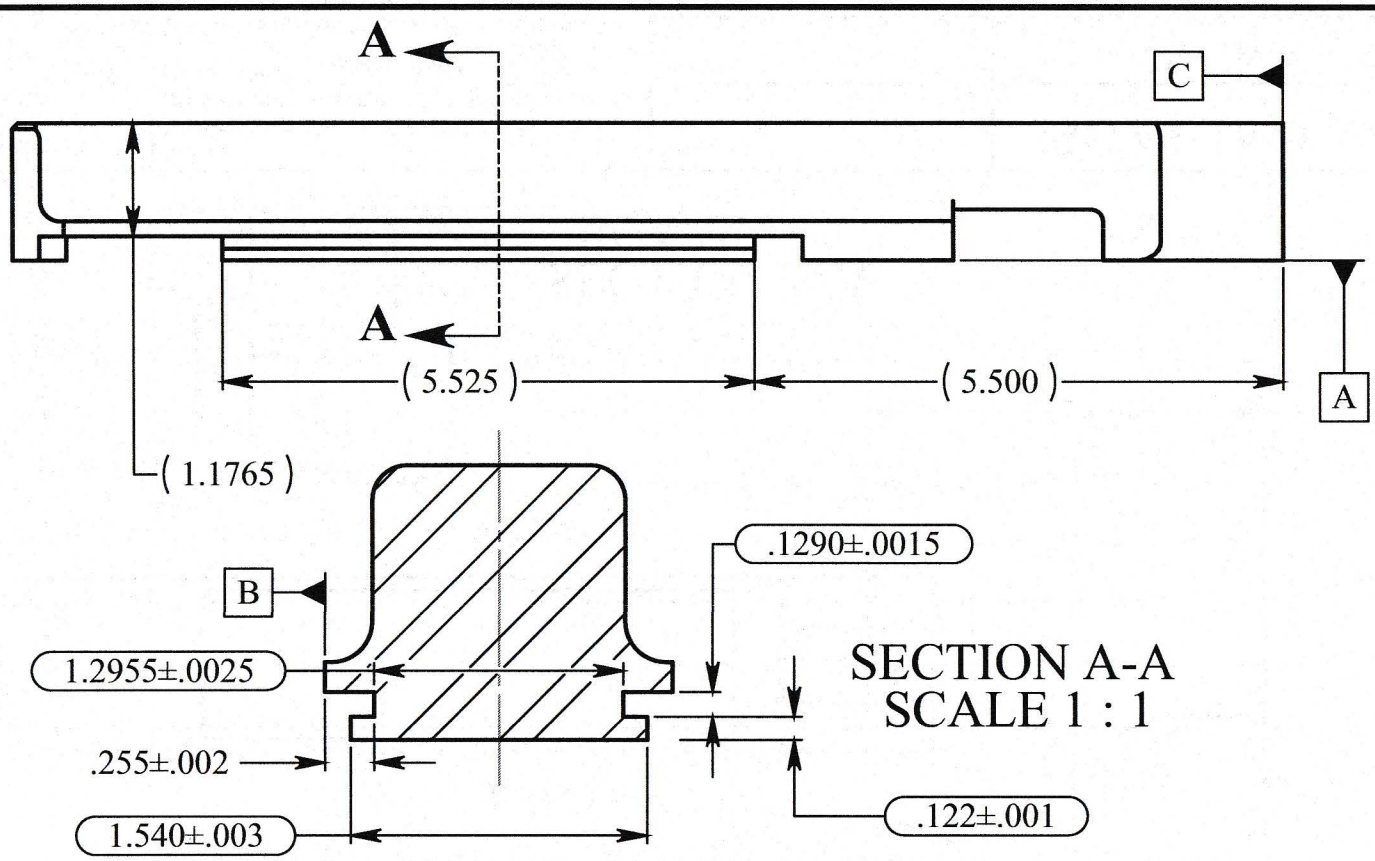
MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Receiver
HARDNESS	OPERATION NAME: Front Width
FINISH	OPERATION NO.: 70
	SCALE: 1:2



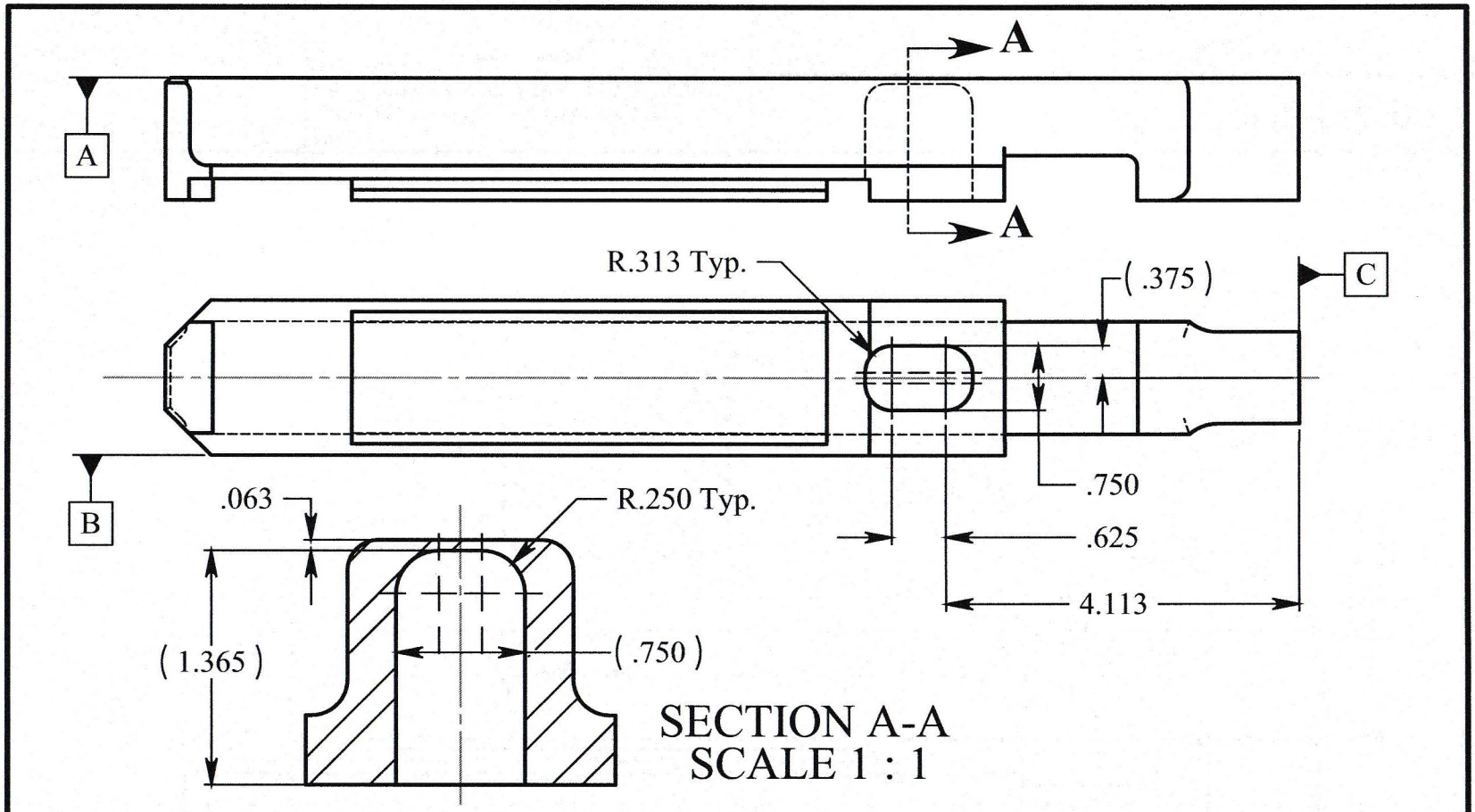
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME: Receiver
		HARDNESS	OPERATION NAME: Magazine Cut
		FINISH	OPERATION NO.: 80 — SCALE: 1:2
	Proprietary and Confidential		



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Receiver
		HARDNESS	OPERATION NAME Housing Relief Cuts
	Proprietary and Confidential	FINISH	OPERATION NO. 90
			SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME Receiver OPERATION NAME Housing Rails OPERATION NO. 100 SCALE 1:2



SECTION A-A
SCALE 1 : 1

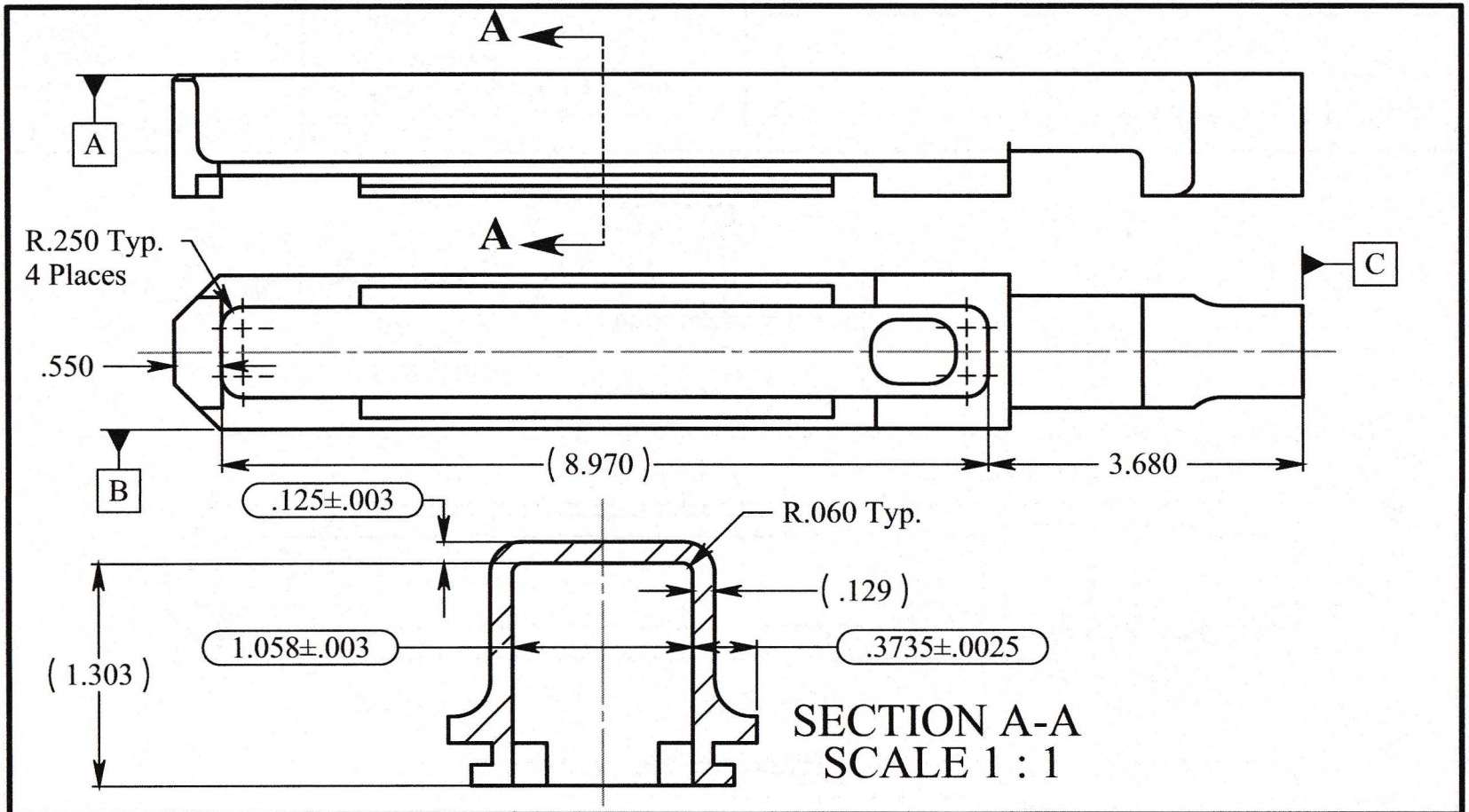
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Receiver
HARDNESS	OPERATION NAME: Cutter Relief
FINISH	OPERATION NO.: 110
	SCALE: 1:2



Dimensions are in Inches

Tolerances:

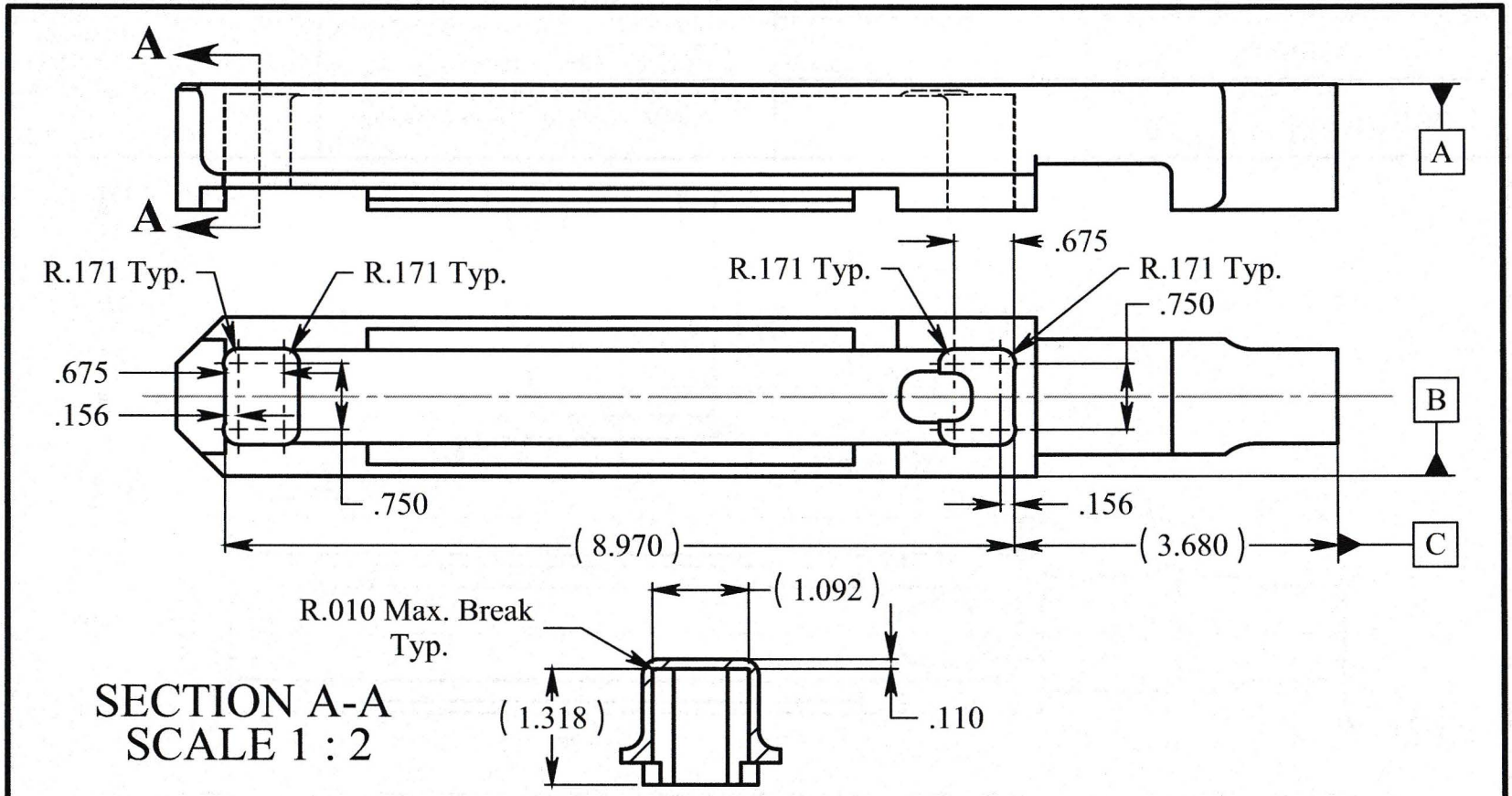
Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:

1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Receiver
HARDNESS	OPERATION NAME: Bolt Opening
FINISH	OPERATION NO.: 120 — SCALE: 1:2



SECTION A-A
SCALE 1 : 2

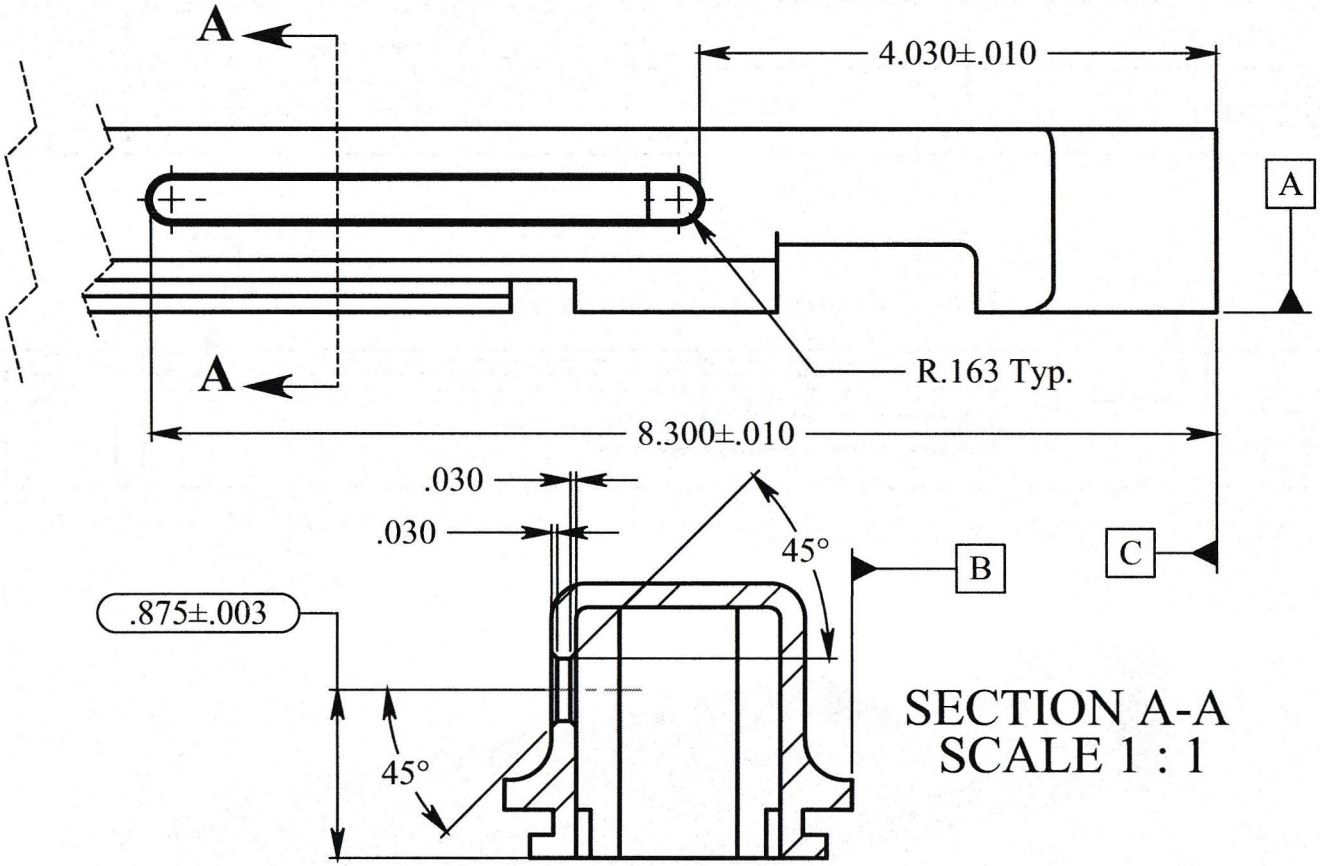
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

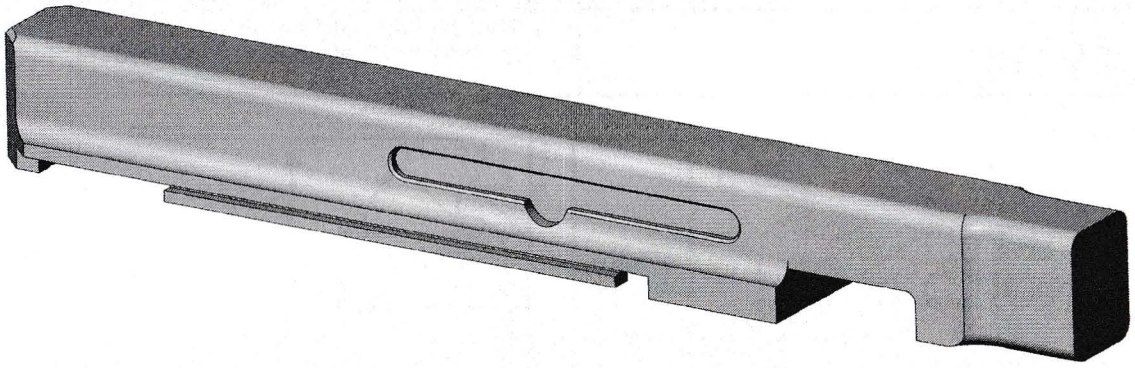
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

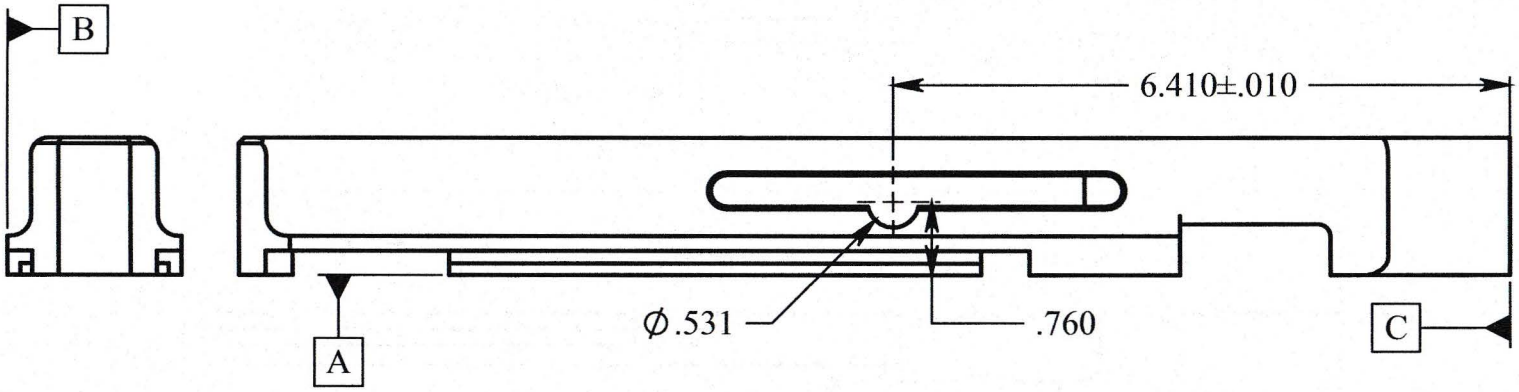
Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME Receiver
HARDNESS	OPERATION NAME Bolt & Rivet Relief
FINISH	OPERATION NO. 130 / SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Receiver OPERATION NAME: Handle Slot OPERATION NO.: 140 SCALE: 1:2





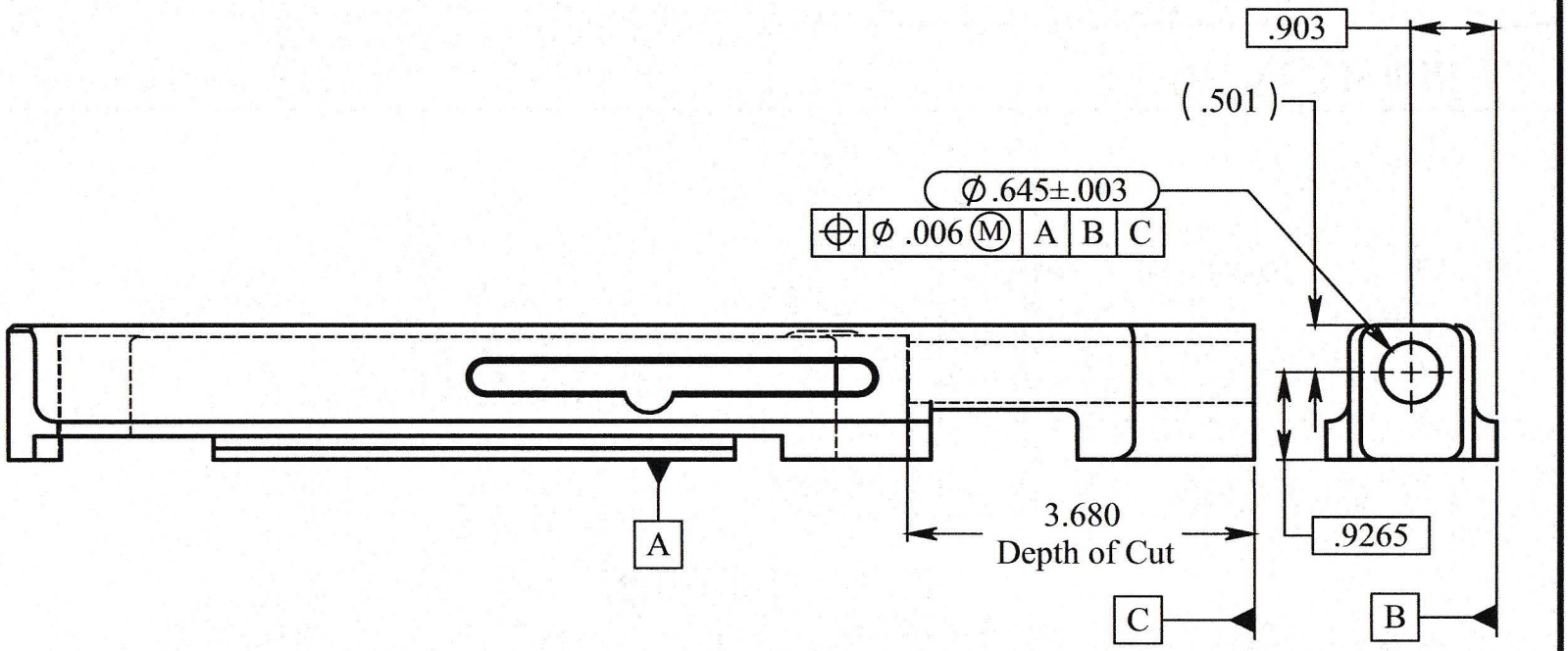
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

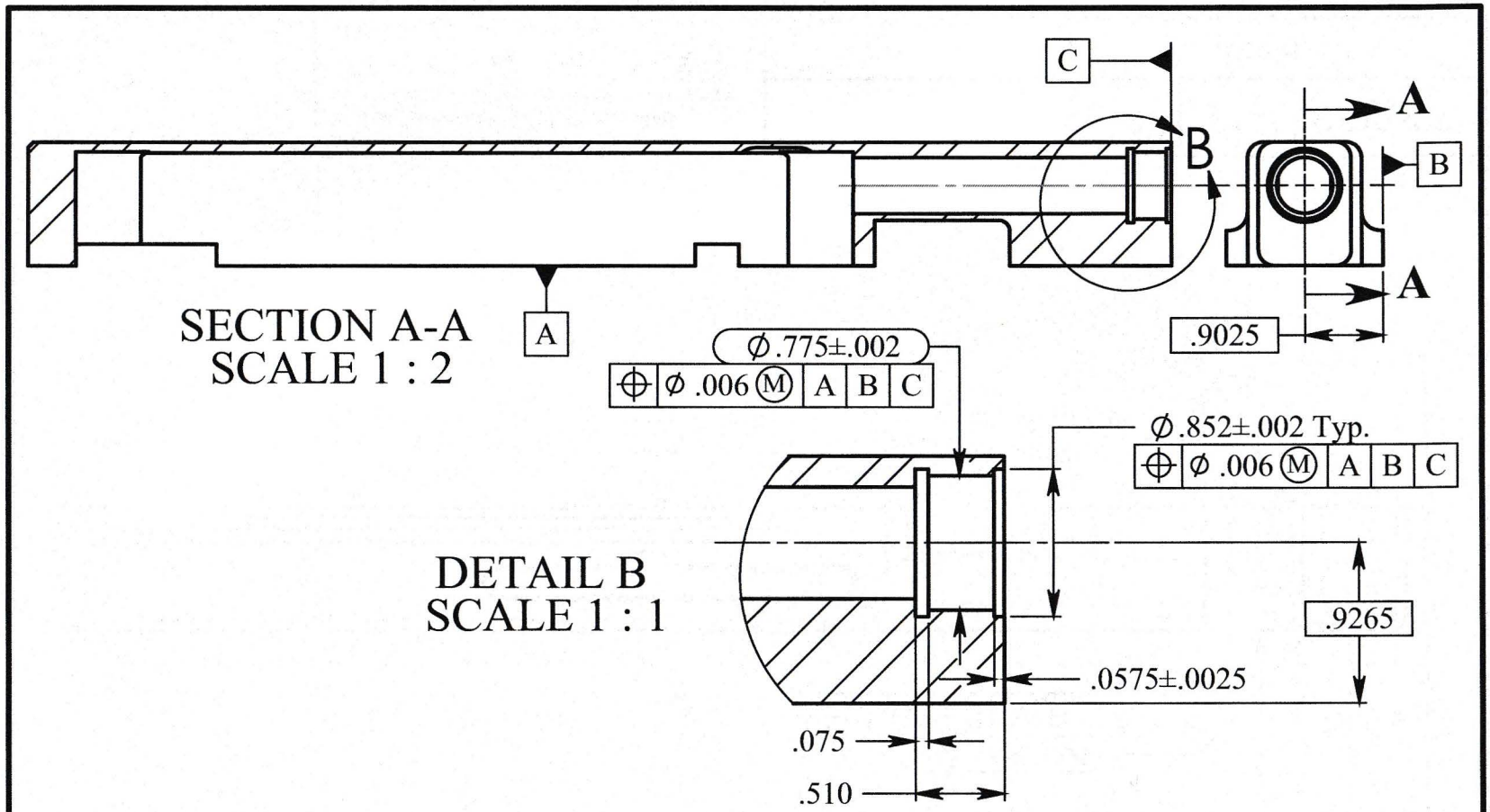
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

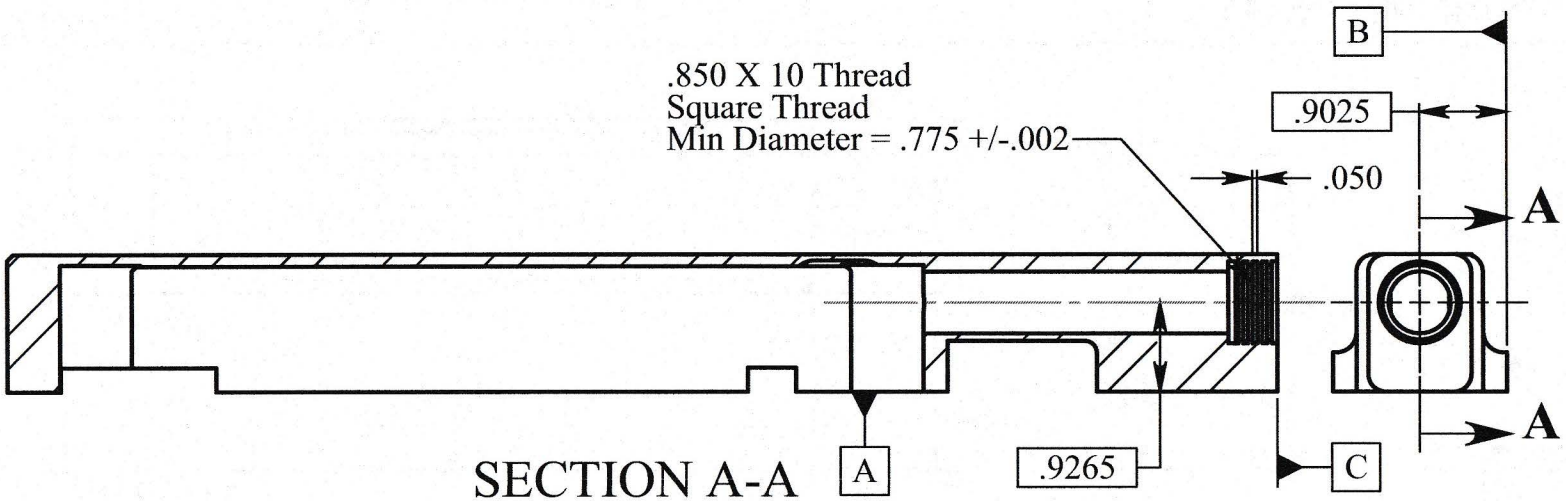
MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME Receiver
HARDNESS	OPERATION NAME Handle Opening
FINISH	OPERATION NO. 150 / SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Receiver
		HARDNESS	OPERATION NAME Bolt Hole
		FINISH	OPERATION NO. 160 / SCALE 1:2
	Proprietary and Confidential		

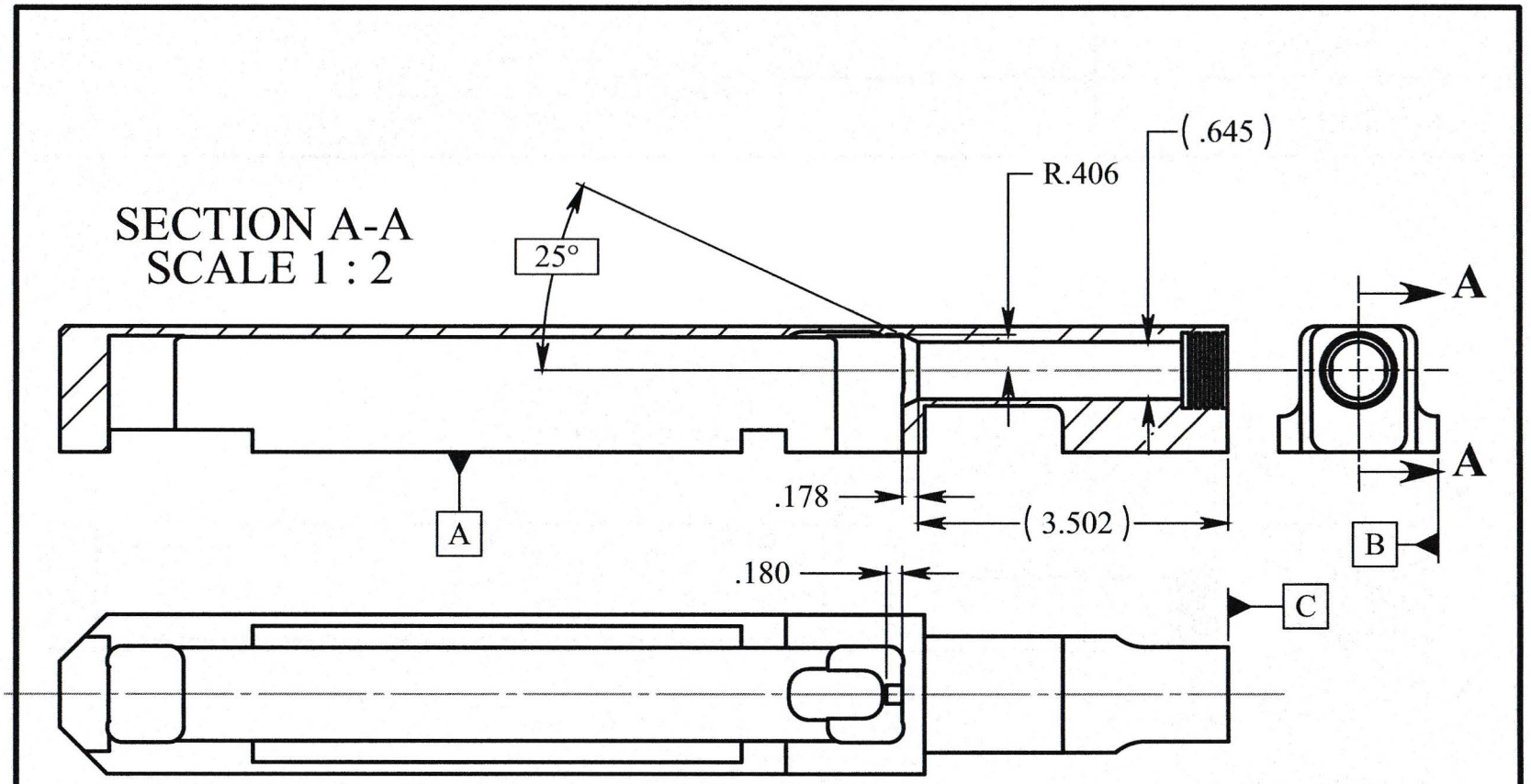


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Receiver
		HARDNESS	OPERATION NAME Barrel Thread Relief
	Proprietary and Confidential	FINISH	OPERATION NO. 170 / SCALE 1:2

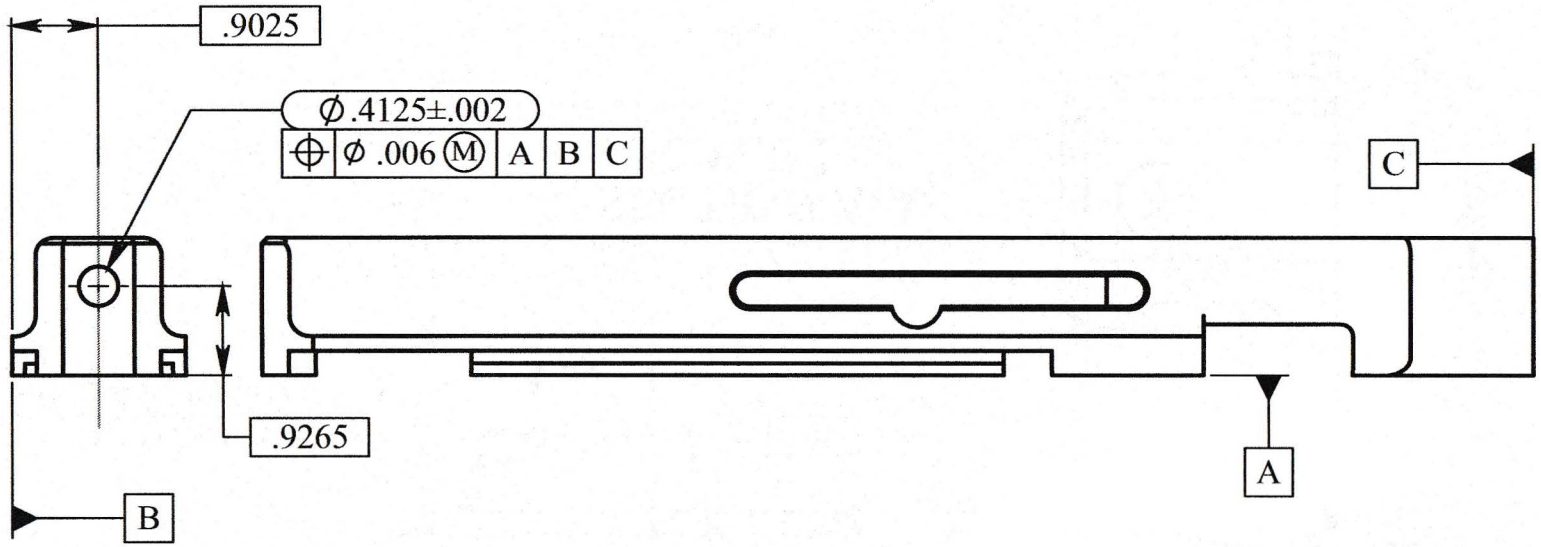


SECTION A-A
SCALE 1 : 2

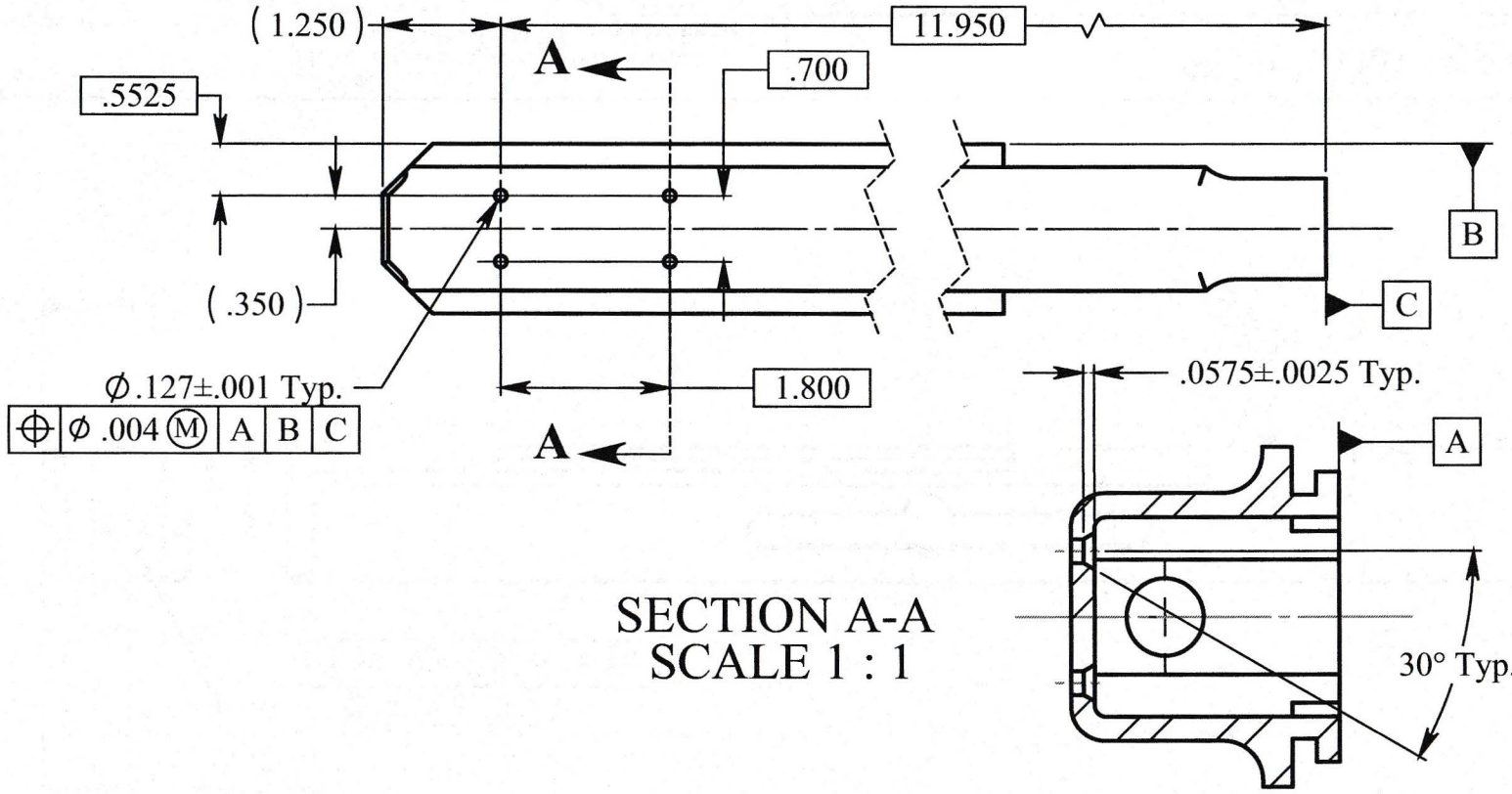
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME: Receiver
		HARDNESS	OPERATION NAME: Barrel Thread
		FINISH	OPERATION NO.: 180 — SCALE: 1:2
	Proprietary and Confidential		



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Receiver
		HARDNESS	OPERATION NAME Bolt Lead
	Proprietary and Confidential	FINISH	OPERATION NO. 190 / SCALE 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Receiver OPERATION NAME: Rear Hole OPERATION NO.: 200 SCALE: 1:2



SECTION A-A
SCALE 1 : 1

Dimensions are in Inches

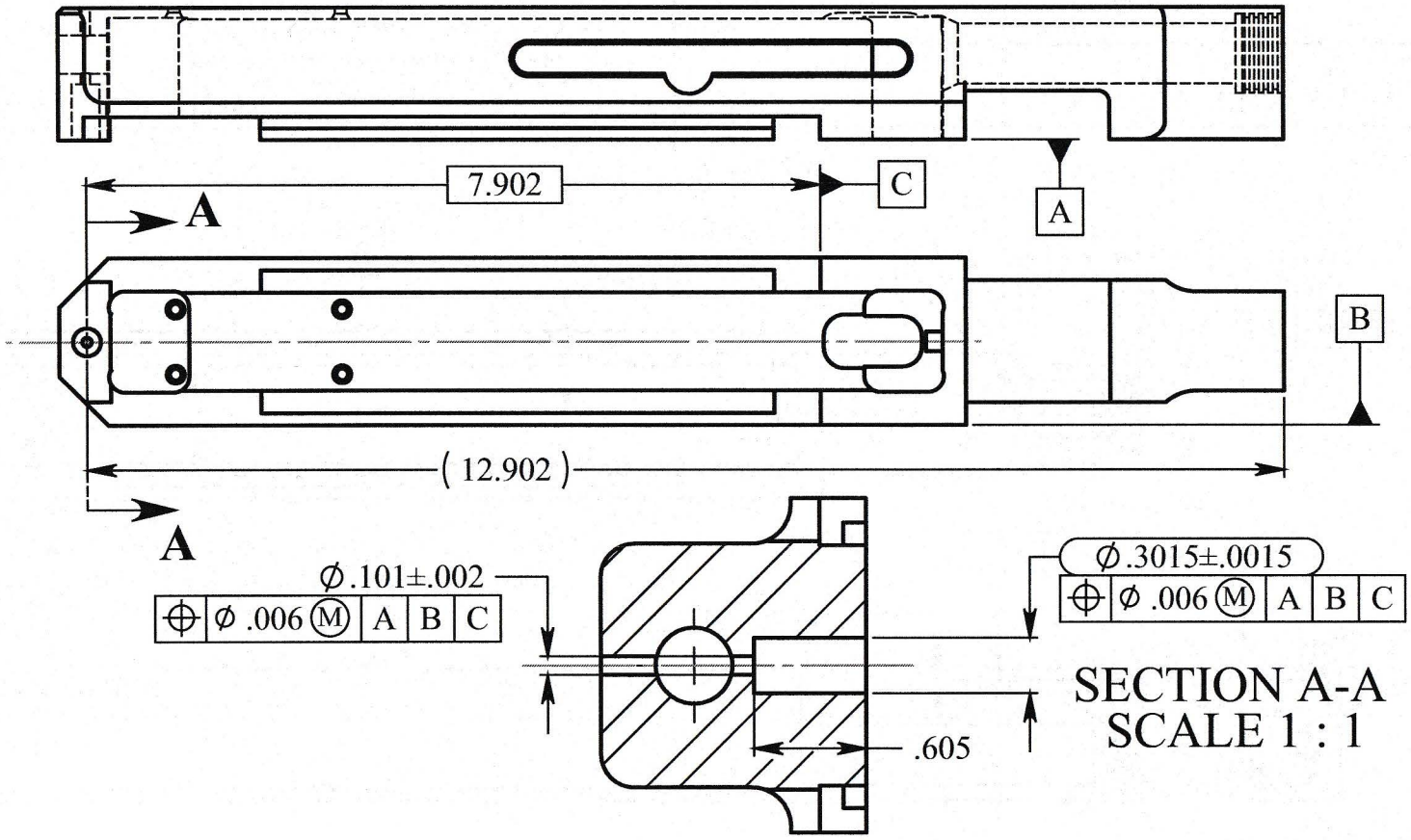
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX

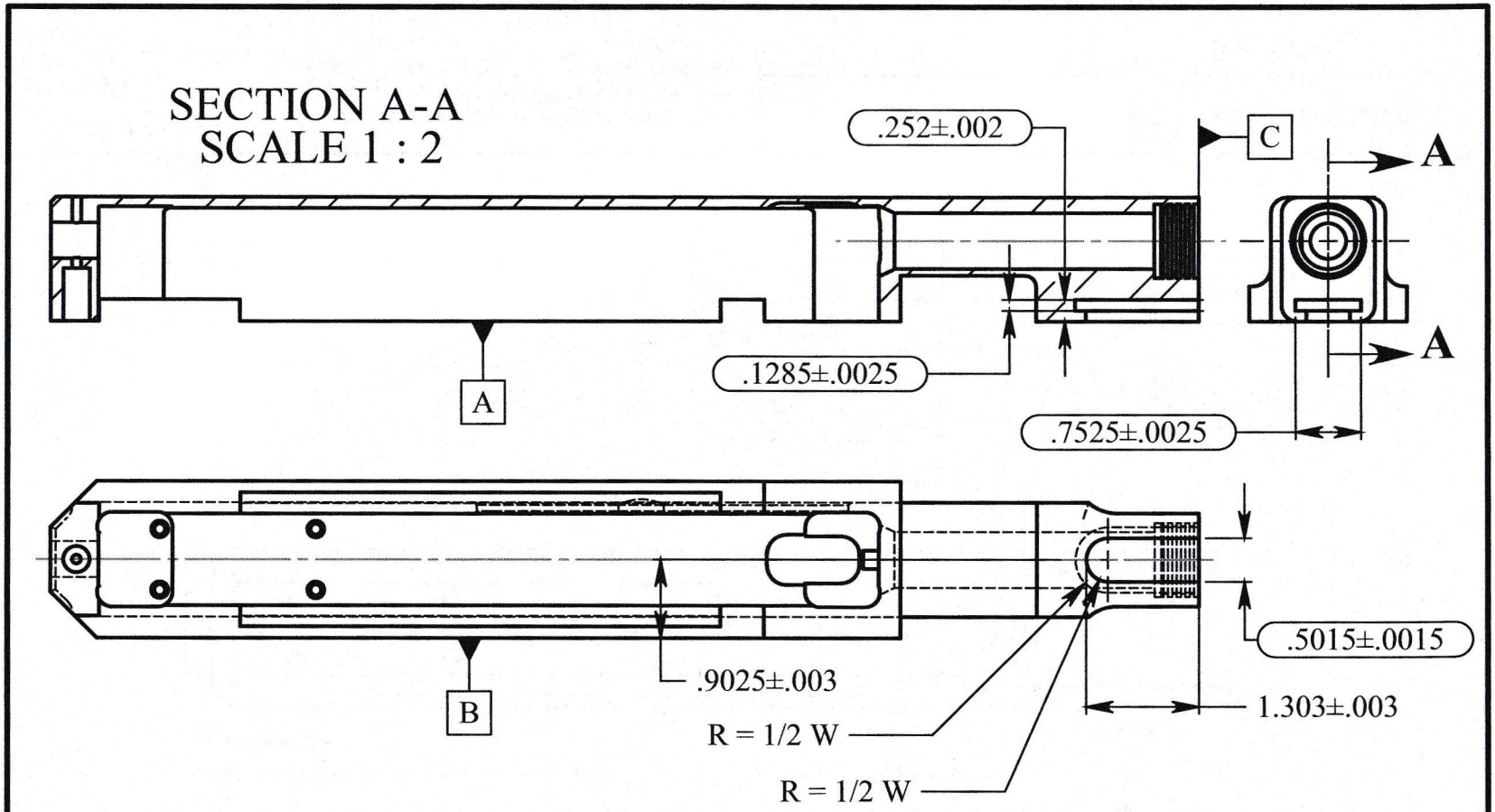
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Receiver
HARDNESS	OPERATION NAME: Rear Sight Rivet Holes
FINISH	OPERATION NO.: 210 / SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Receiver OPERATION NAME: Retaining Hole OPERATION NO.: 220 SCALE: 1:2



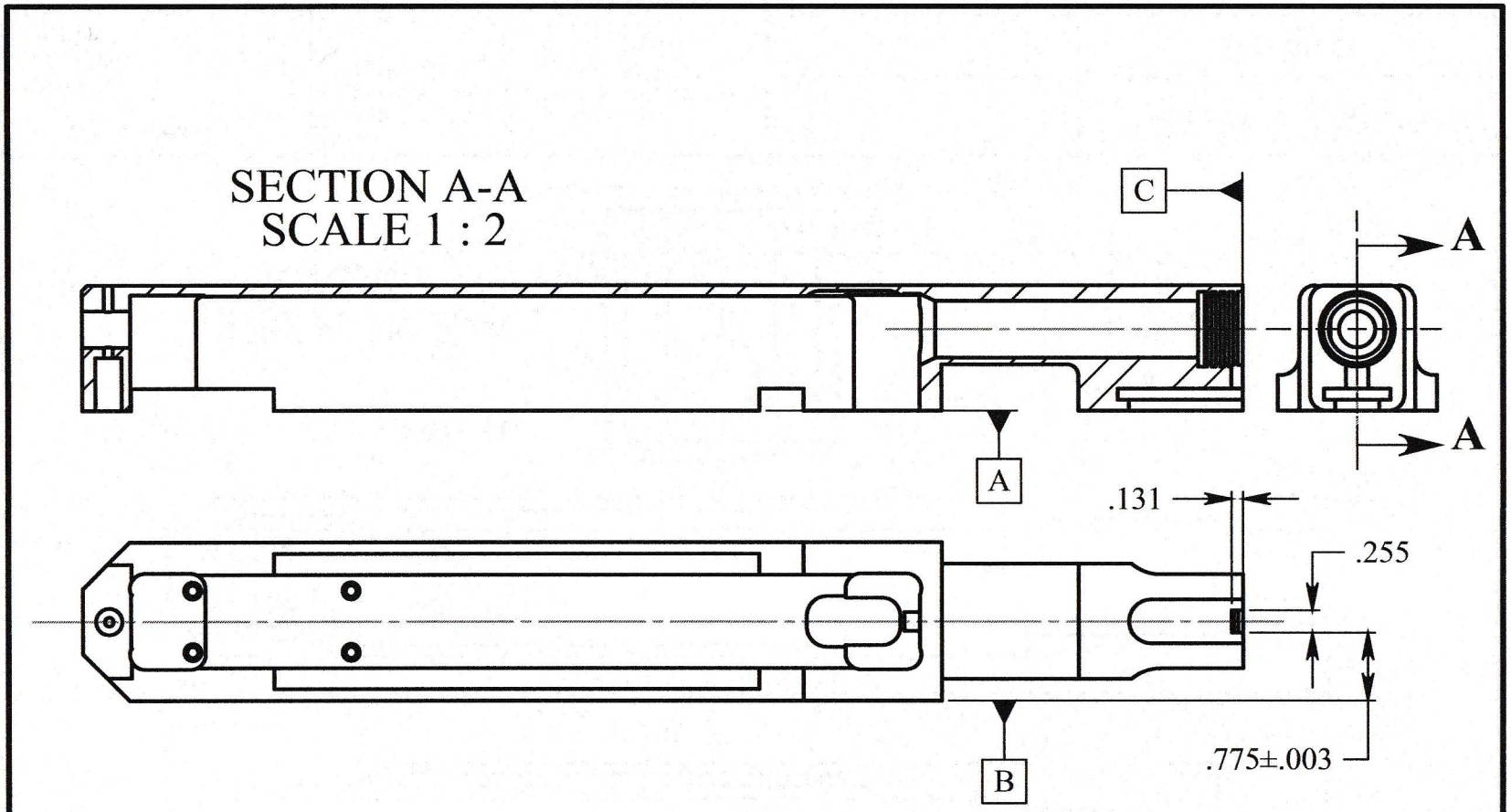
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

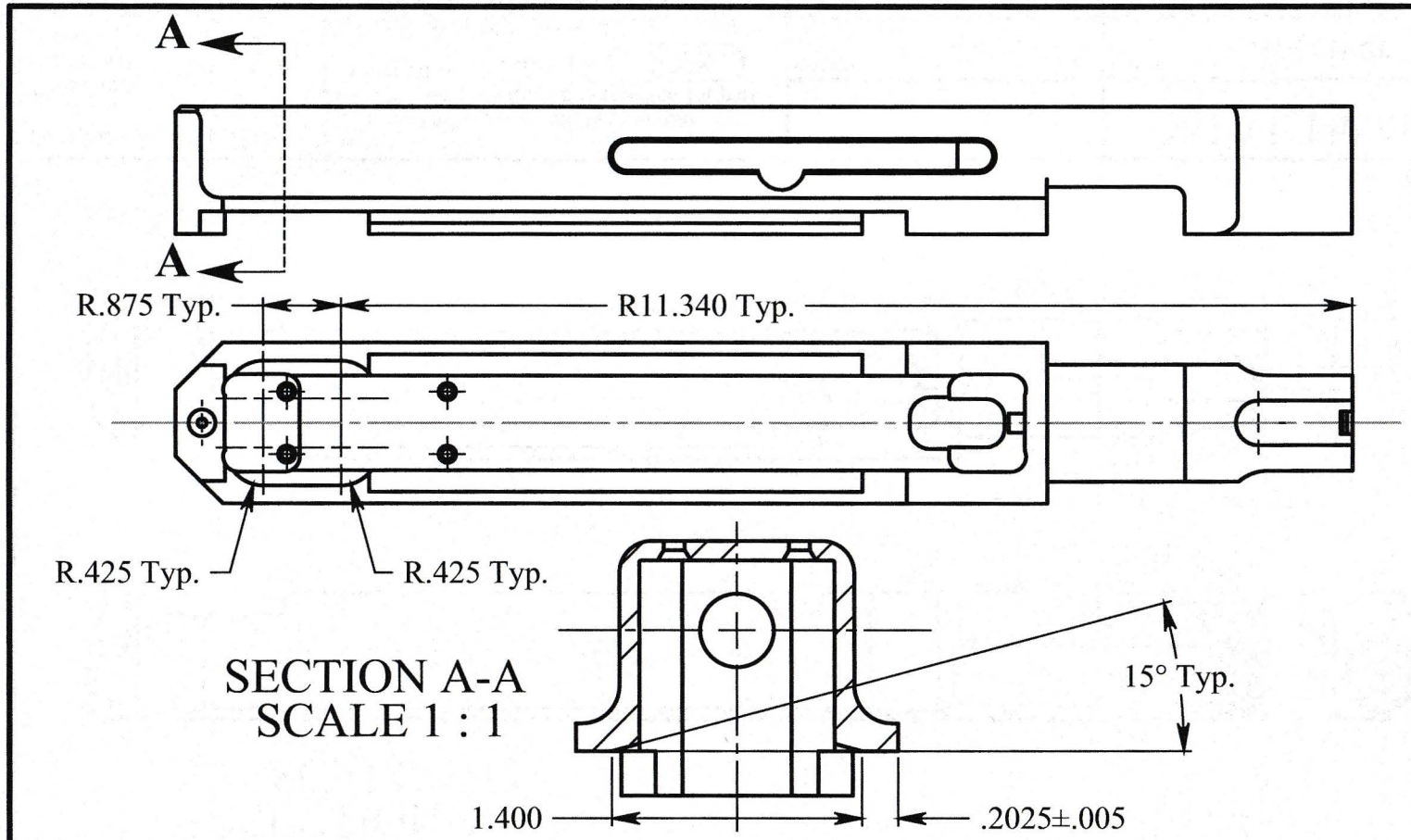
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Receiver
HARDNESS	OPERATION NAME: Fore End Iron Cut
FINISH	OPERATION NO.: 230 — SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Receiver OPERATION NAME: Iron Slot OPERATION NO.: 240 SCALE: 1:2



SECTION A-A
SCALE 1 : 1

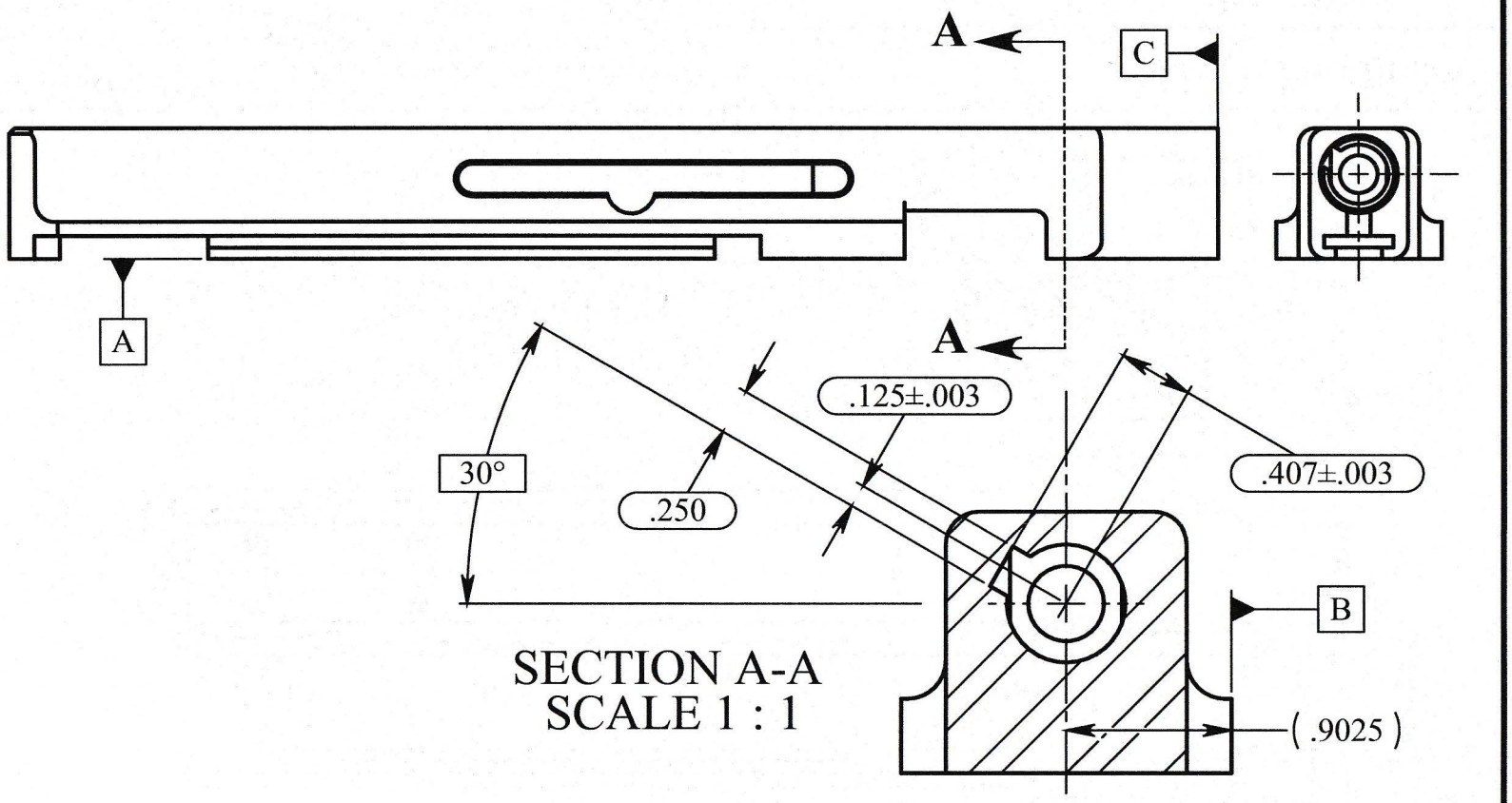
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

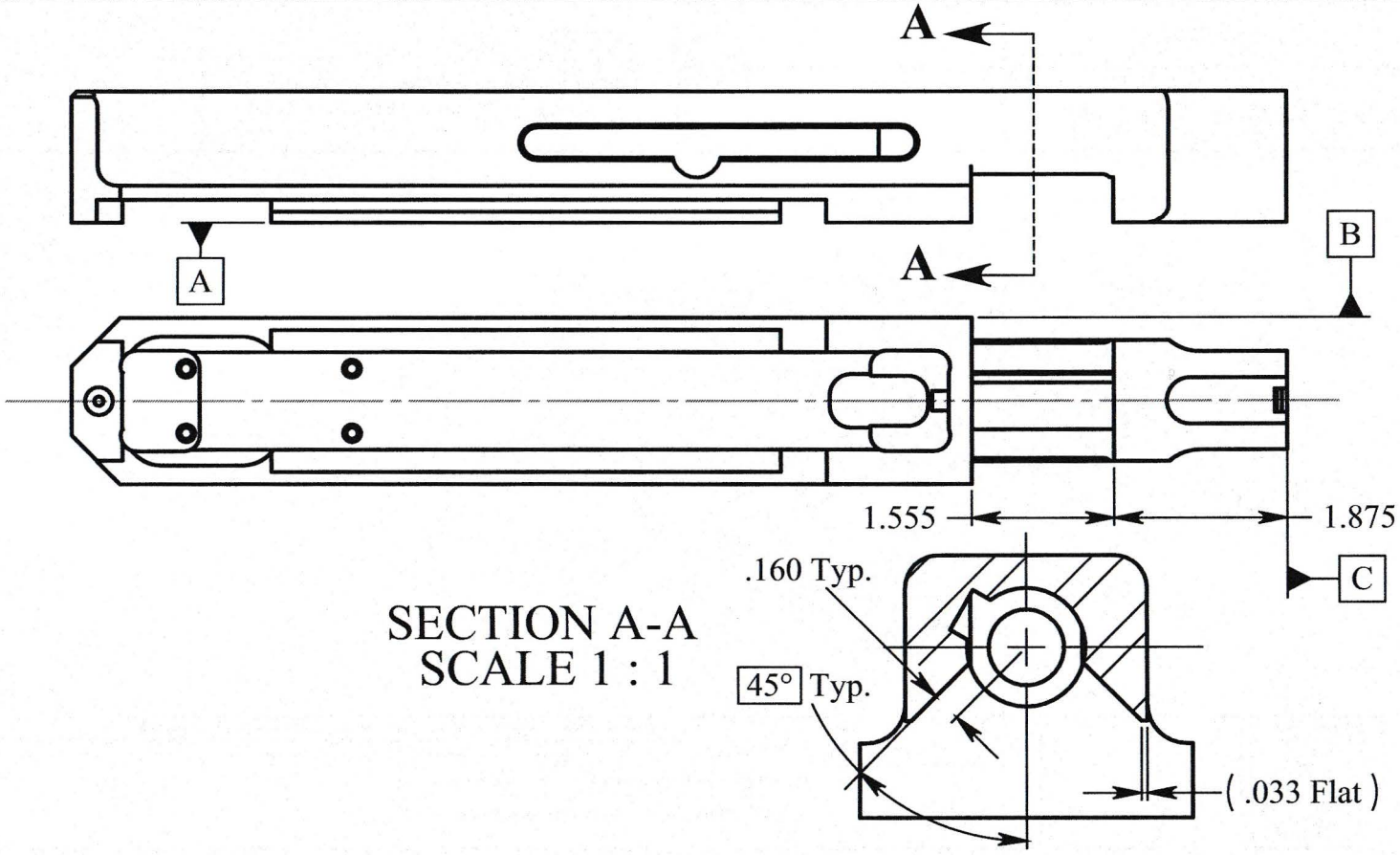
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Receiver
HARDNESS	OPERATION NAME: Rear Angle Cut
FINISH	OPERATION NO.: 250 — SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Receiver
		HARDNESS	OPERATION NAME Extractor Cut
		FINISH	OPERATION NO. 260 / SCALE 1:2
	Proprietary and Confidential		



SECTION A-A
SCALE 1 : 1

Dimensions are in Inches

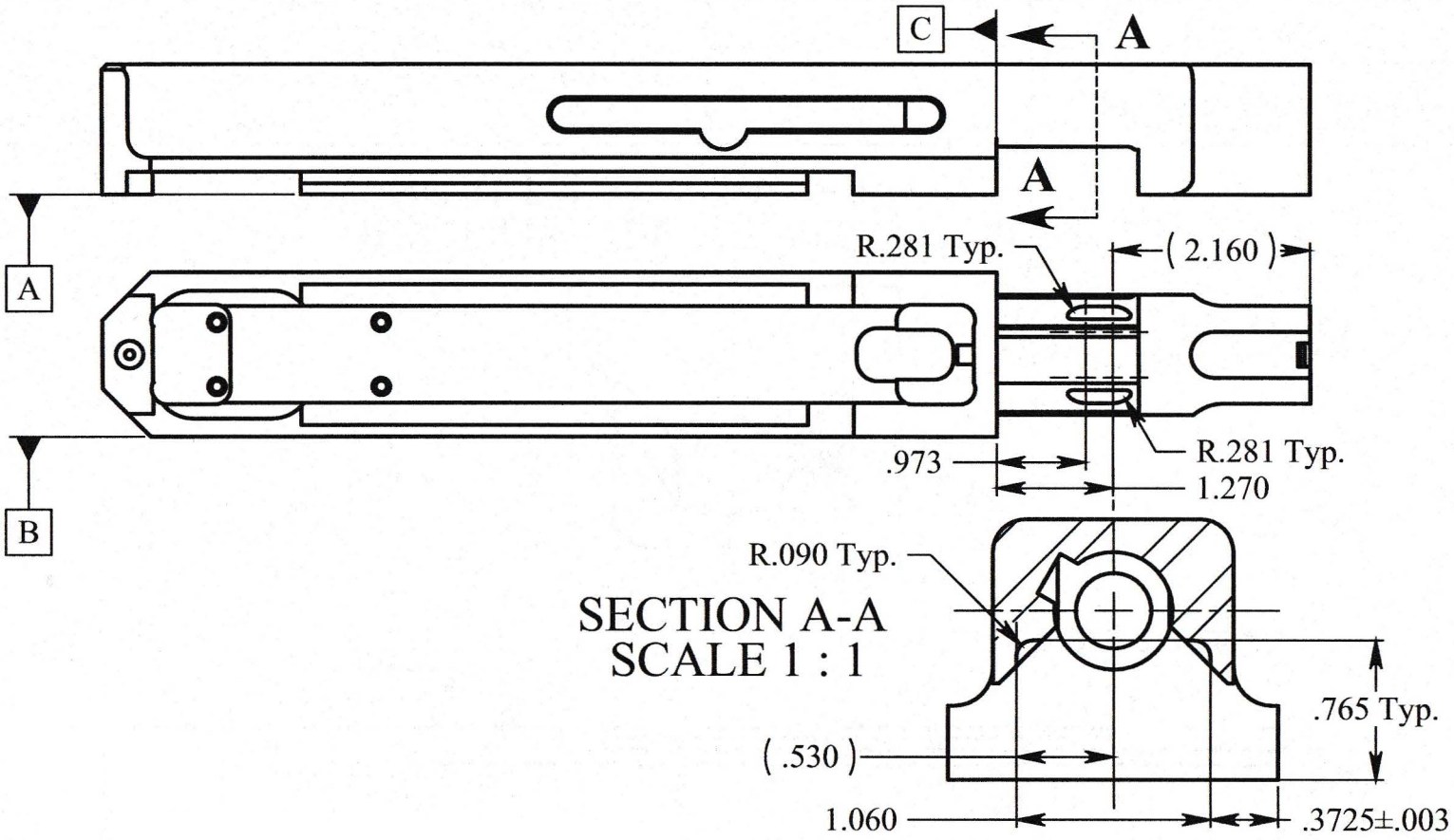
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX

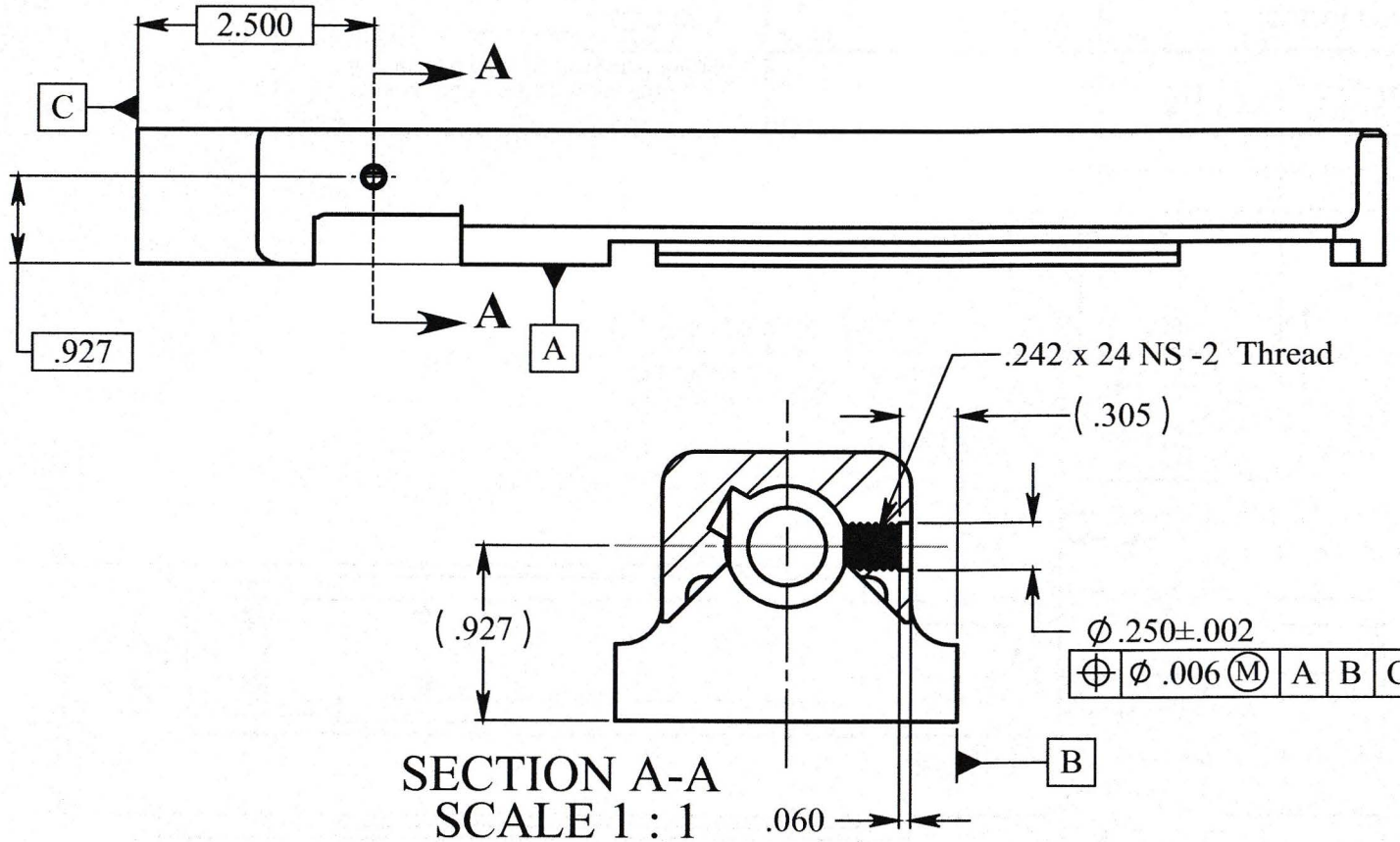
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

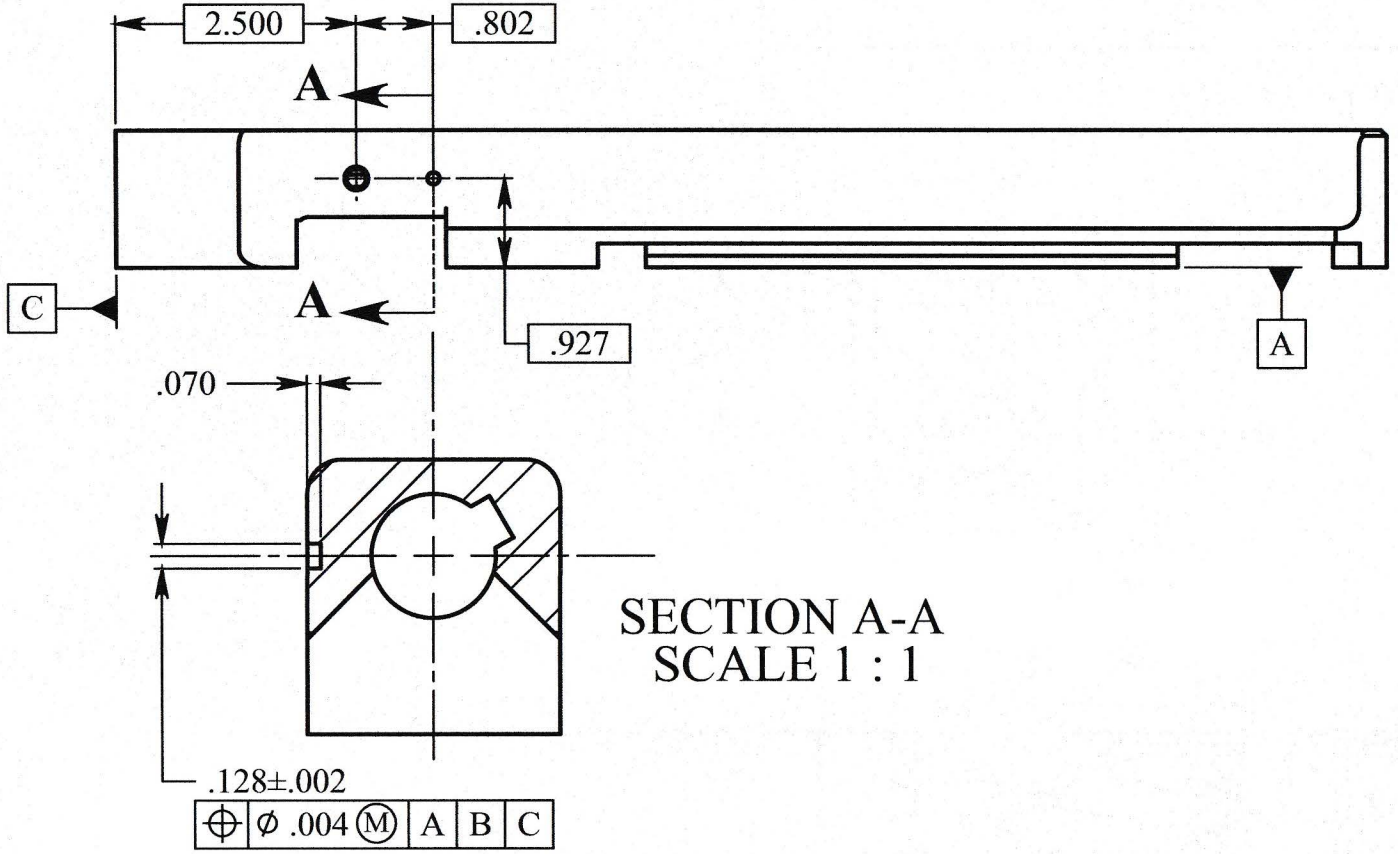
MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Receiver
HARDNESS	OPERATION NAME: Mag Angle Cut
FINISH	OPERATION NO.: 270 — SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Receiver OPERATION NAME: Mag. Clearance OPERATION NO.: 280 SCALE: 1:2

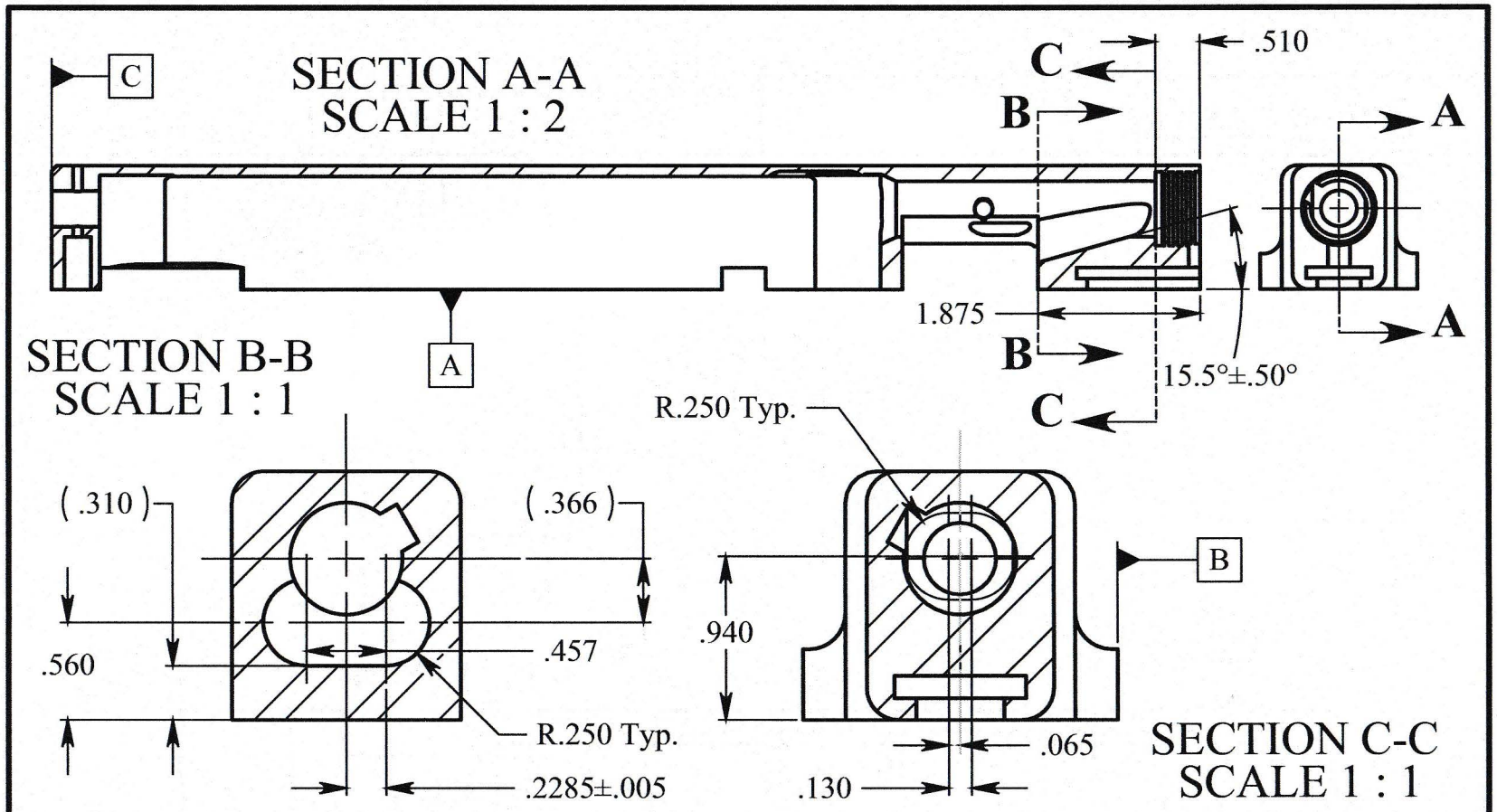


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME Receiver OPERATION NAME Ejector Hole OPERATION NO. 290 SCALE 1:2

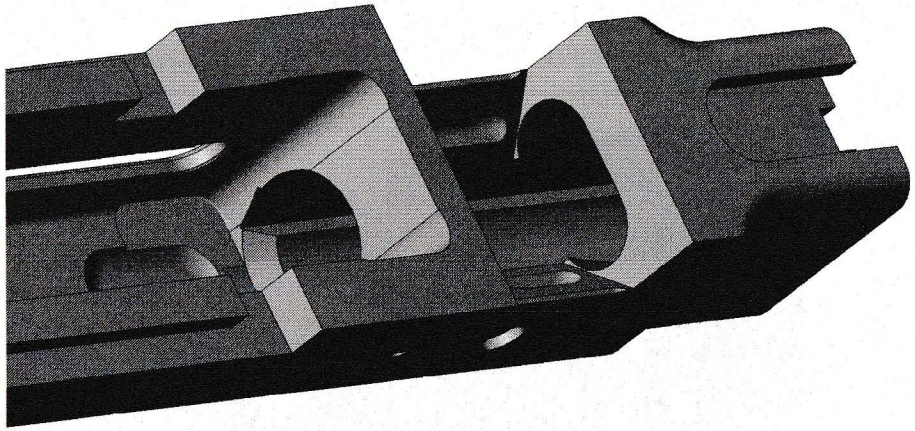


SECTION A-A
SCALE 1 : 1

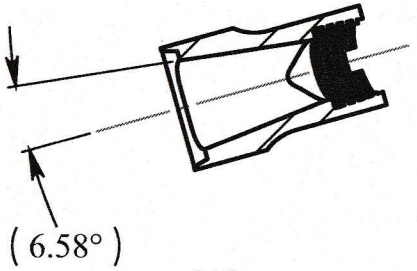
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL	M1A1 Thompson	
		HEAT TREAT	PART NAME Receiver	
		HARDNESS	OPERATION NAME Ejector Ret. Hole	
		FINISH	OPERATION NO. 300	SCALE 1:2

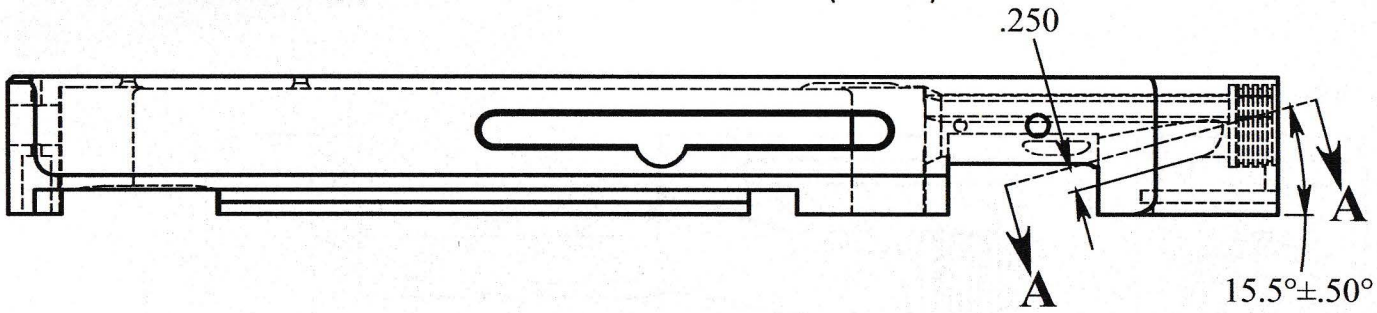


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Receiver
		HARDNESS	OPERATION NAME Feed Cut (Drawing 1)
	Proprietary and Confidential	FINISH	OPERATION NO. 310 / SCALE 1:2



SECTION A-A
SCALE 1 : 2

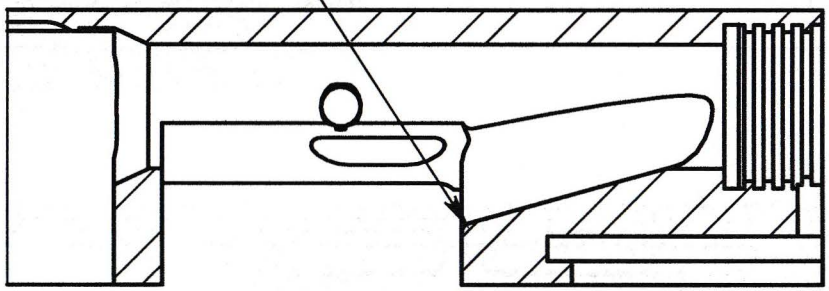


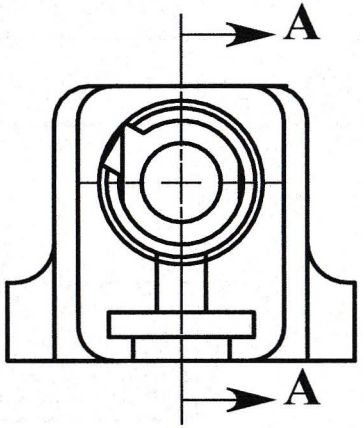


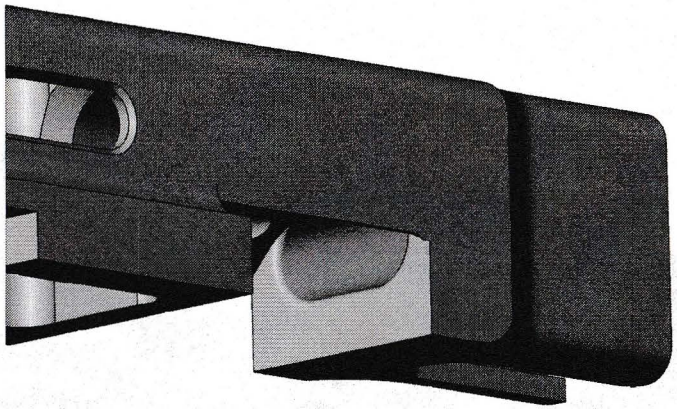
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Receiver
		HARDNESS	OPERATION NAME Feed Cut (Drawing 2)
		FINISH	OPERATION NO. 310 / SCALE 1:2
	Proprietary and Confidential		

R.050 Typ.
Around Contour

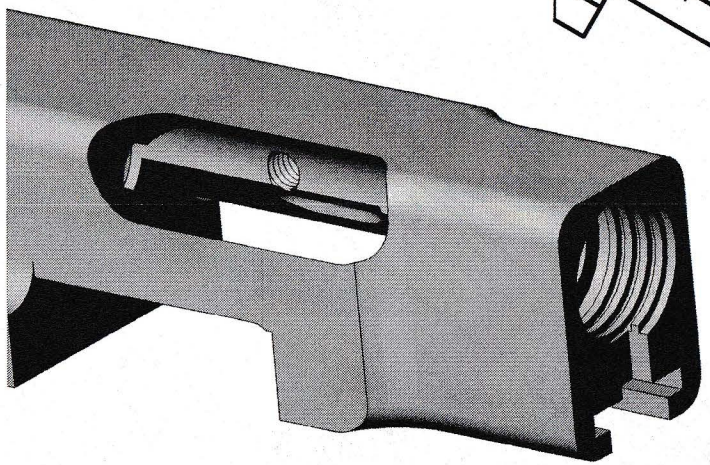
SECTION A-A
SCALE 1 : 1

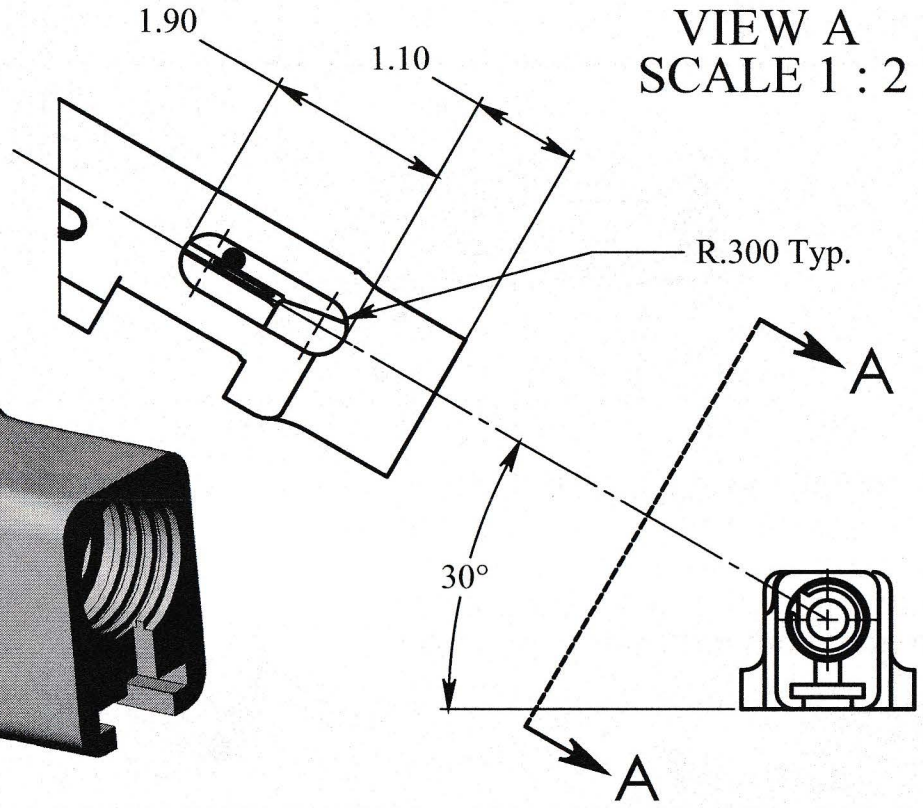






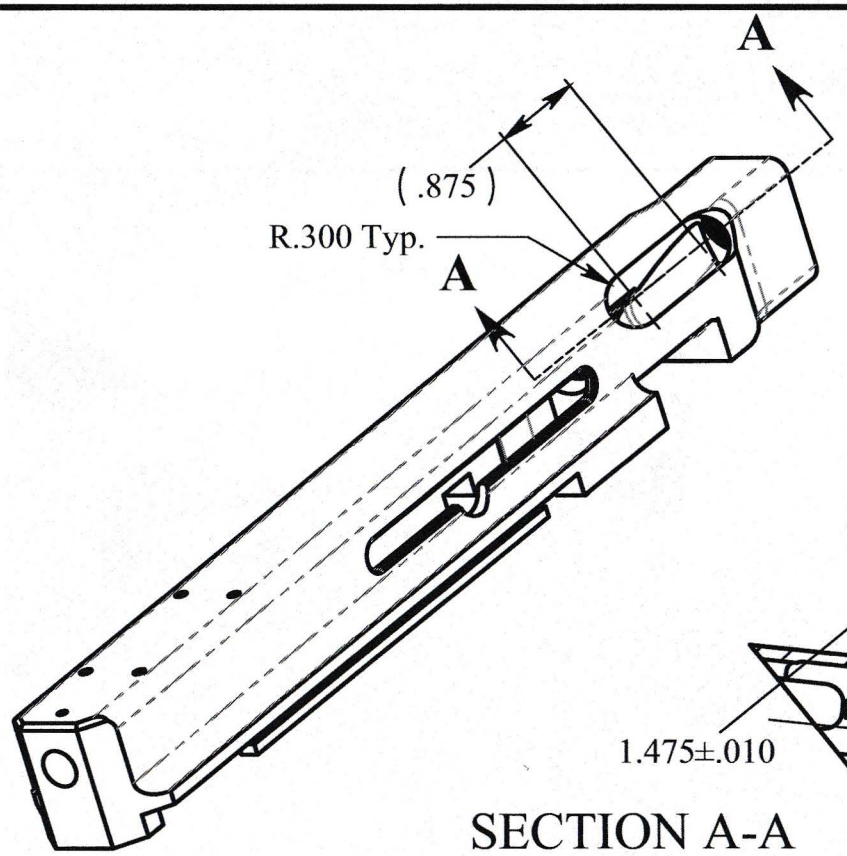
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Receiver
		HARDNESS	OPERATION NAME Feed Cut Radius
		FINISH	OPERATION NO. 320 / SCALE 1:1
	Proprietary and Confidential		

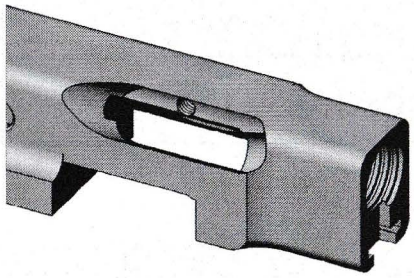




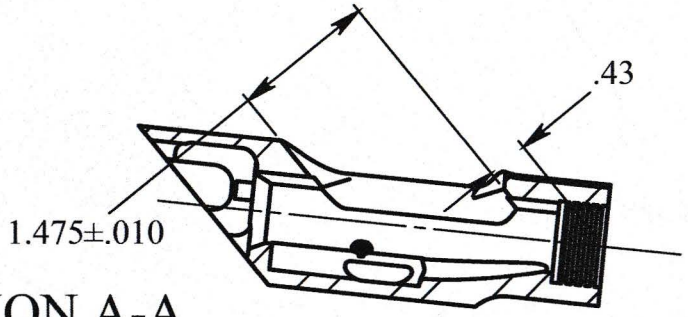
VIEW A
SCALE 1 : 2

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX ← 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX ← Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Receiver OPERATION NAME: Port Cut 1 OPERATION NO.: 330 SCALE: 1:2





Port Cut II requires the receiver be rotated 30° as in Port Cut 1 and then rotated 45° as shown to cut the second port opening. The cutter ℄ is on the same ℄ as the barrel and bolt hole.



SECTION A-A
SCALE 1 : 2

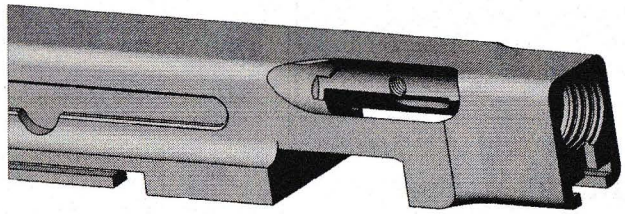
Dimensions are in Inches

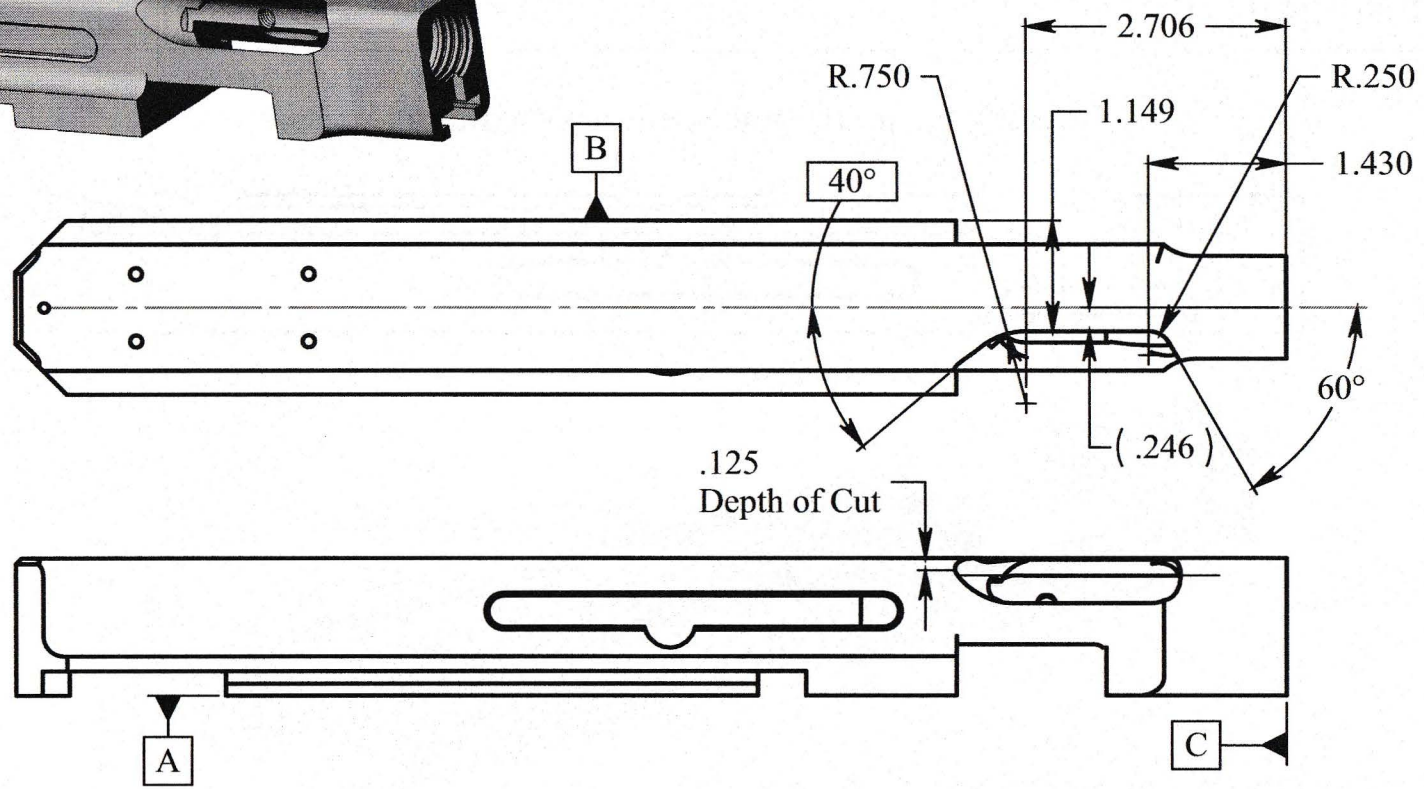
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

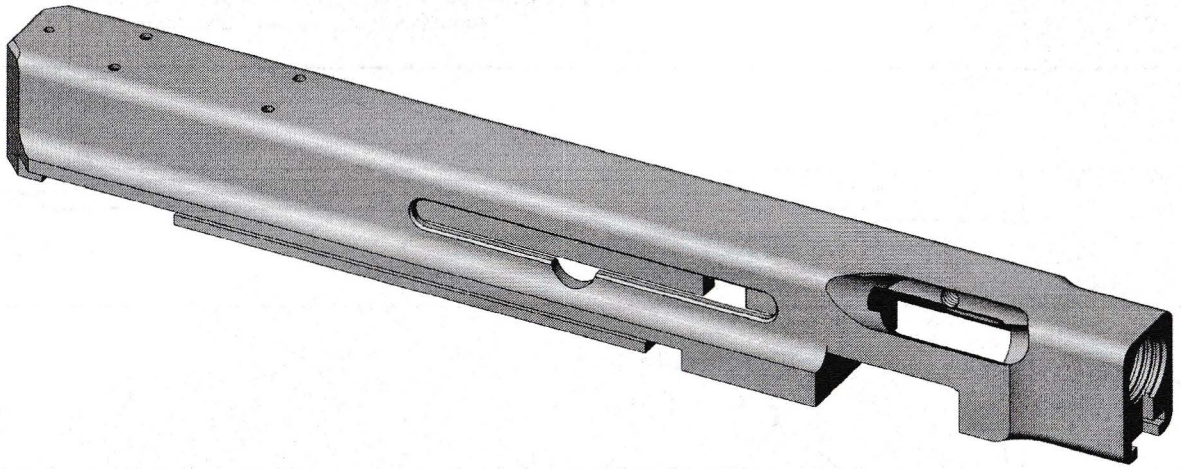
Proprietary and Confidential

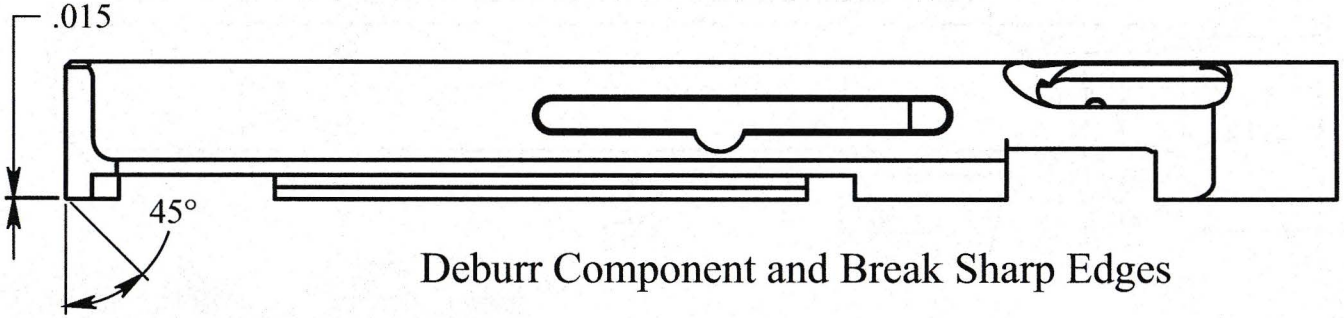
MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Receiver
HARDNESS	OPERATION NAME: Port Cut 2
FINISH	OPERATION NO.: 340 — SCALE: 1:2





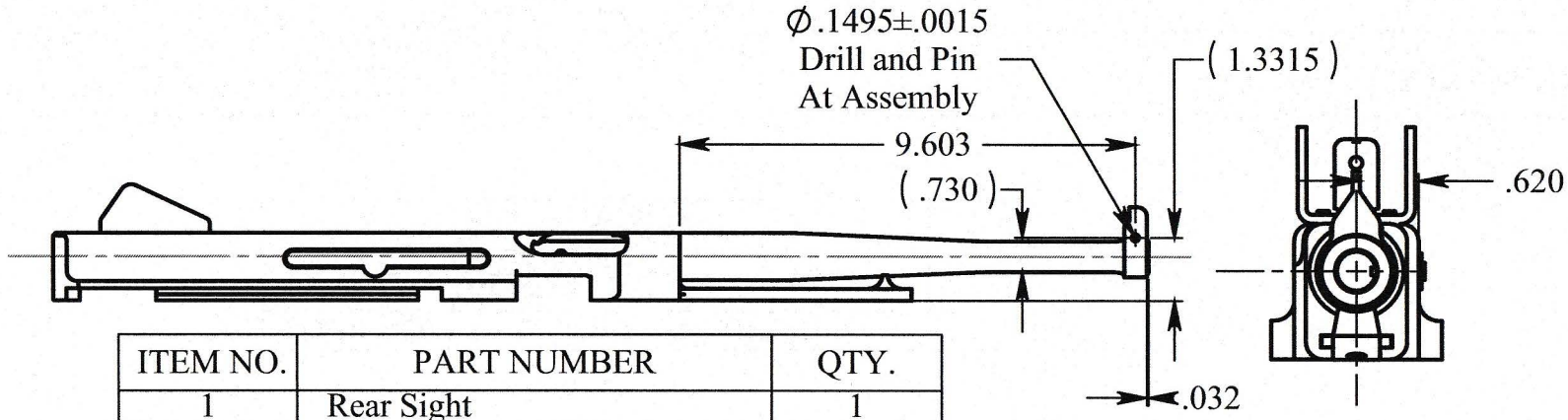
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Receiver OPERATION NAME: Port Cut 3 OPERATION NO.: 350 SCALE: 1:2





Deburr Component and Break Sharp Edges

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Receiver
		HARDNESS	OPERATION NAME Finishing Operations
		FINISH Mag. Phosphate	OPERATION NO. 360 / SCALE 1:2



ITEM NO.	PART NUMBER	QTY.
1	Rear Sight	1
2	Rear Sight Rivet	4
3	Barrel	1
4	Fore End Iron	1
5	Front Sight	1
7	Front Sight Retaining Pin	1
8	Ejector Assembly	1
	Ejector Base	1
	Ejector Post	1
	Ejector Locator Pin	1
11	Receiver	1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX)

2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH

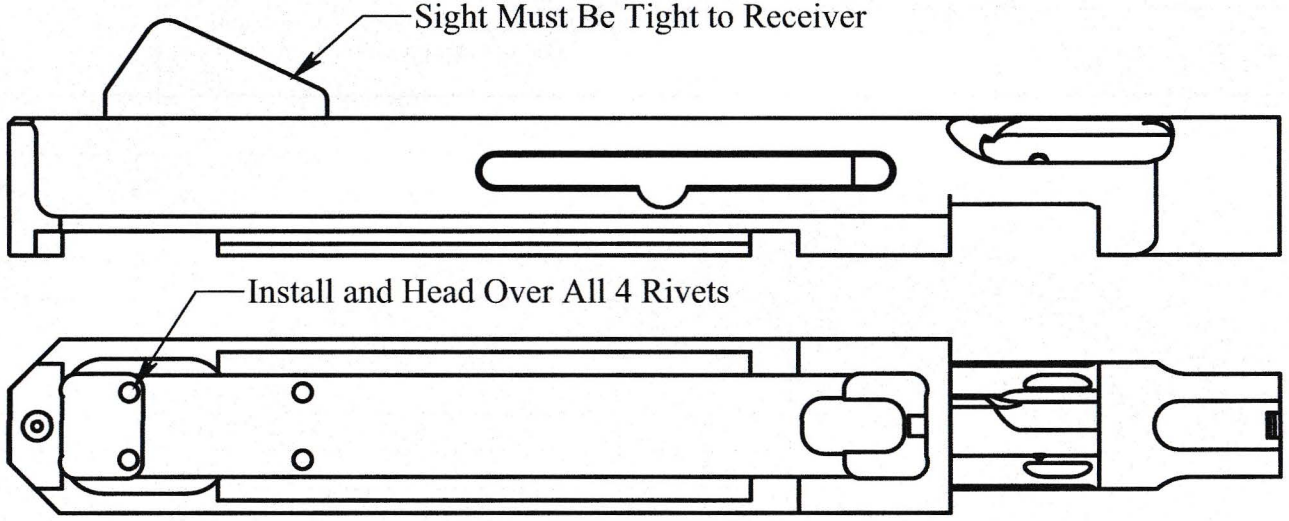
M1A1 Thompson

PART NAME
Receiver Assembly

OPERATION NAME

OPERATION NO.

SCALE
1:4/1:2



ITEM NO.	PART NUMBER	QTY.
1	Receiver	1
2	Rear Sight	1
3	Rear Sight Rivet	4

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH
Mag. Phosphate

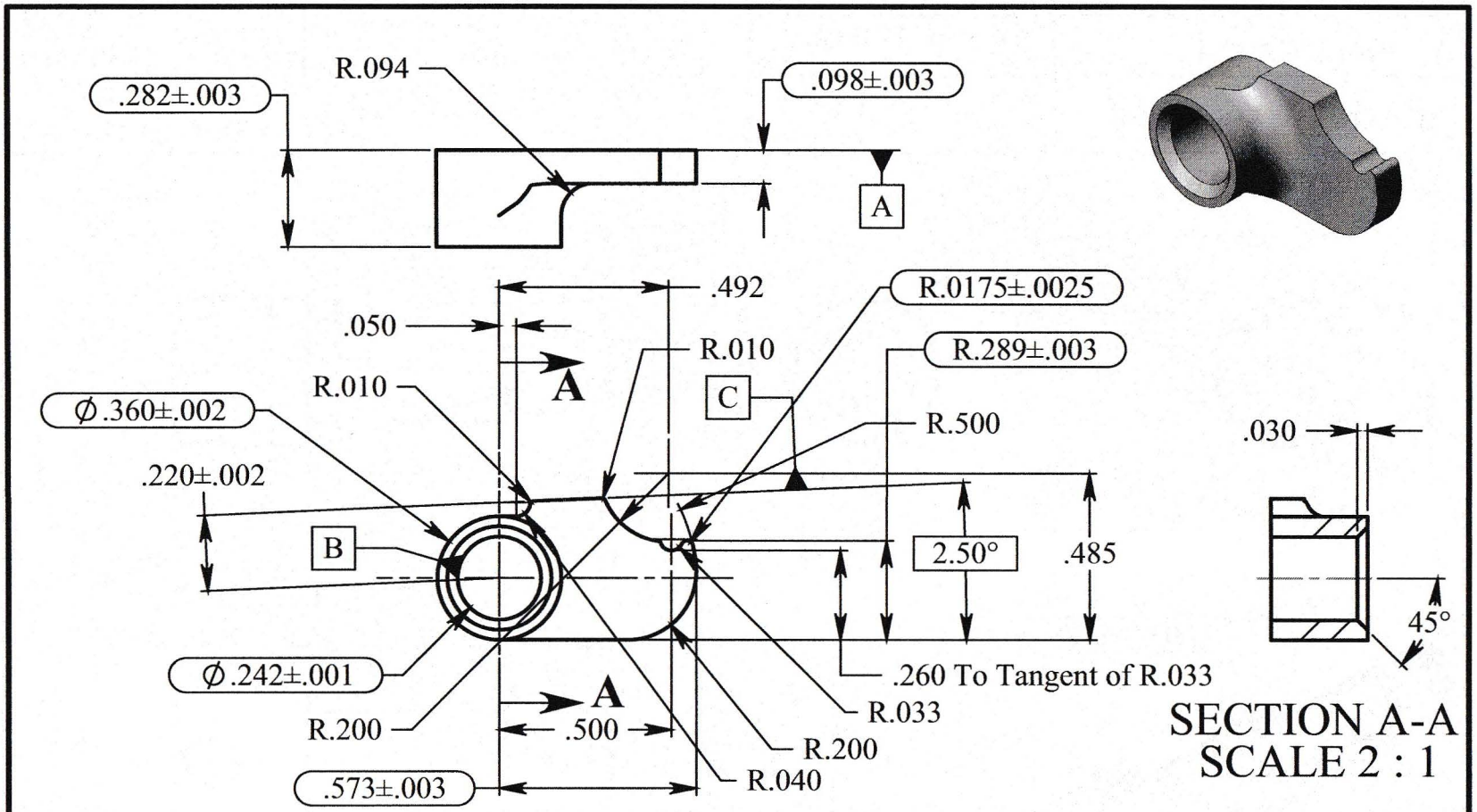
M1A1 Thompson

PART NAME
Receiver Sub-Assy

OPERATION NAME
Sight Riveting

OPERATION NO.

SCALE
1:2



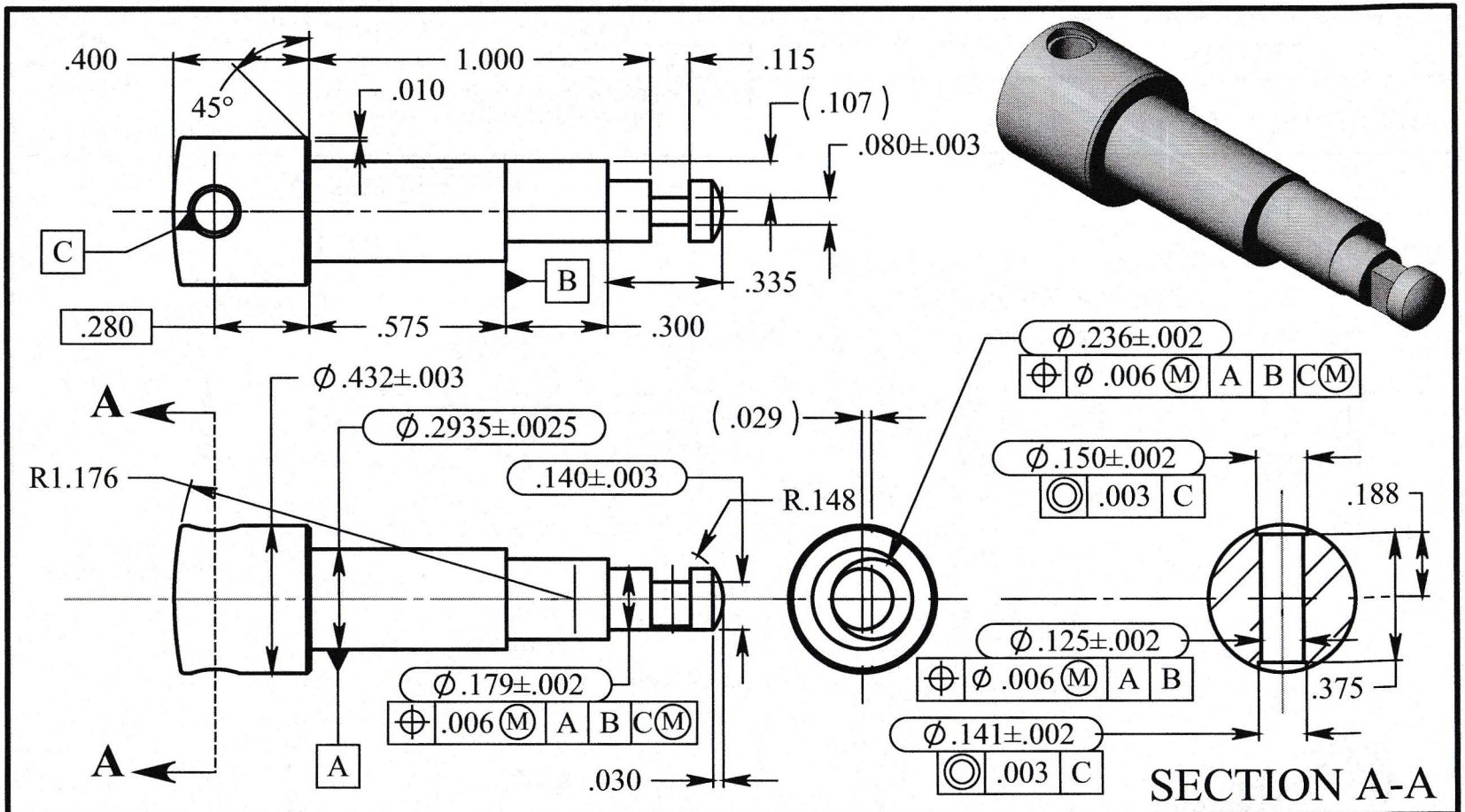
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

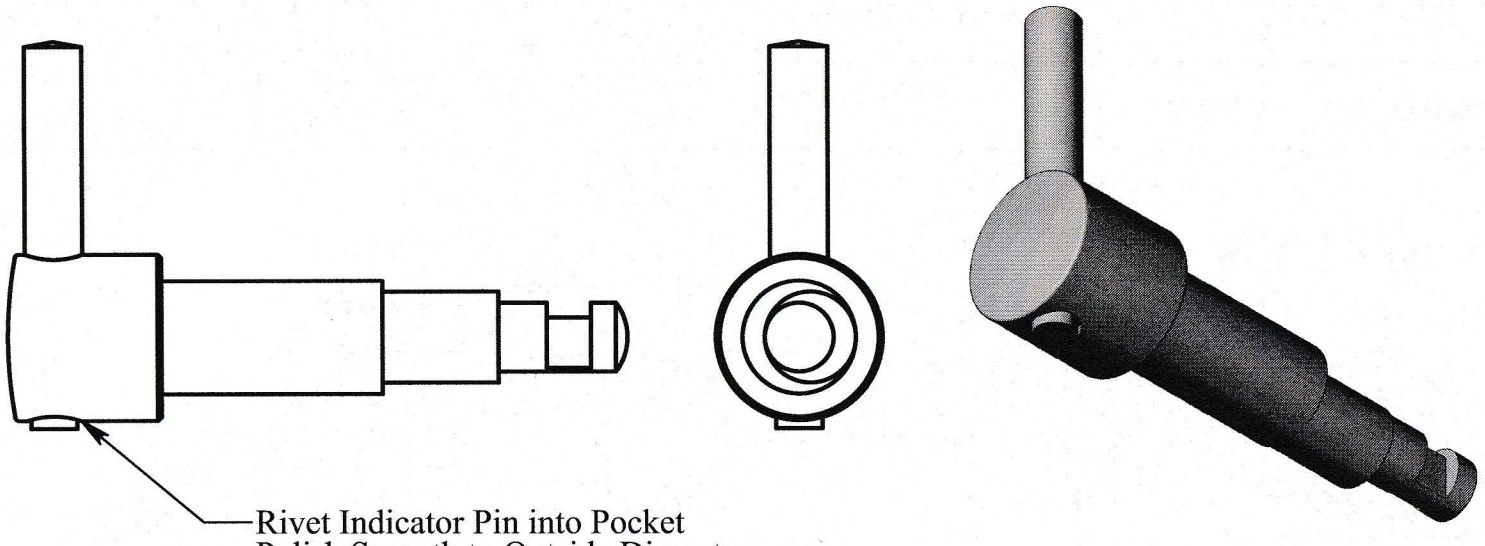
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 4140	M1A1 Thompson
HEAT TREAT: Harden &Temper	PART NAME: Rocker
HARDNESS: HRC 40 - 45	OPERATION NAME:
FINISH: Black Oxide	OPERATION NO.: / SCALE: 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL: AISI 1215 HEAT TREAT: Carburize .01 Case HARDNESS: HR15N 75 - 80 FINISH: None	M1A1 Thompson PART NAME: Rocker Pivot OPERATION NAME: OPERATION NO.: SCALE: 2:1
	Proprietary and Confidential		



ITEM NO.	PART NUMBER	QTY.
1	Rocker Pivot	1
2	Indicator Pin	1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH
Mag. Phosphate

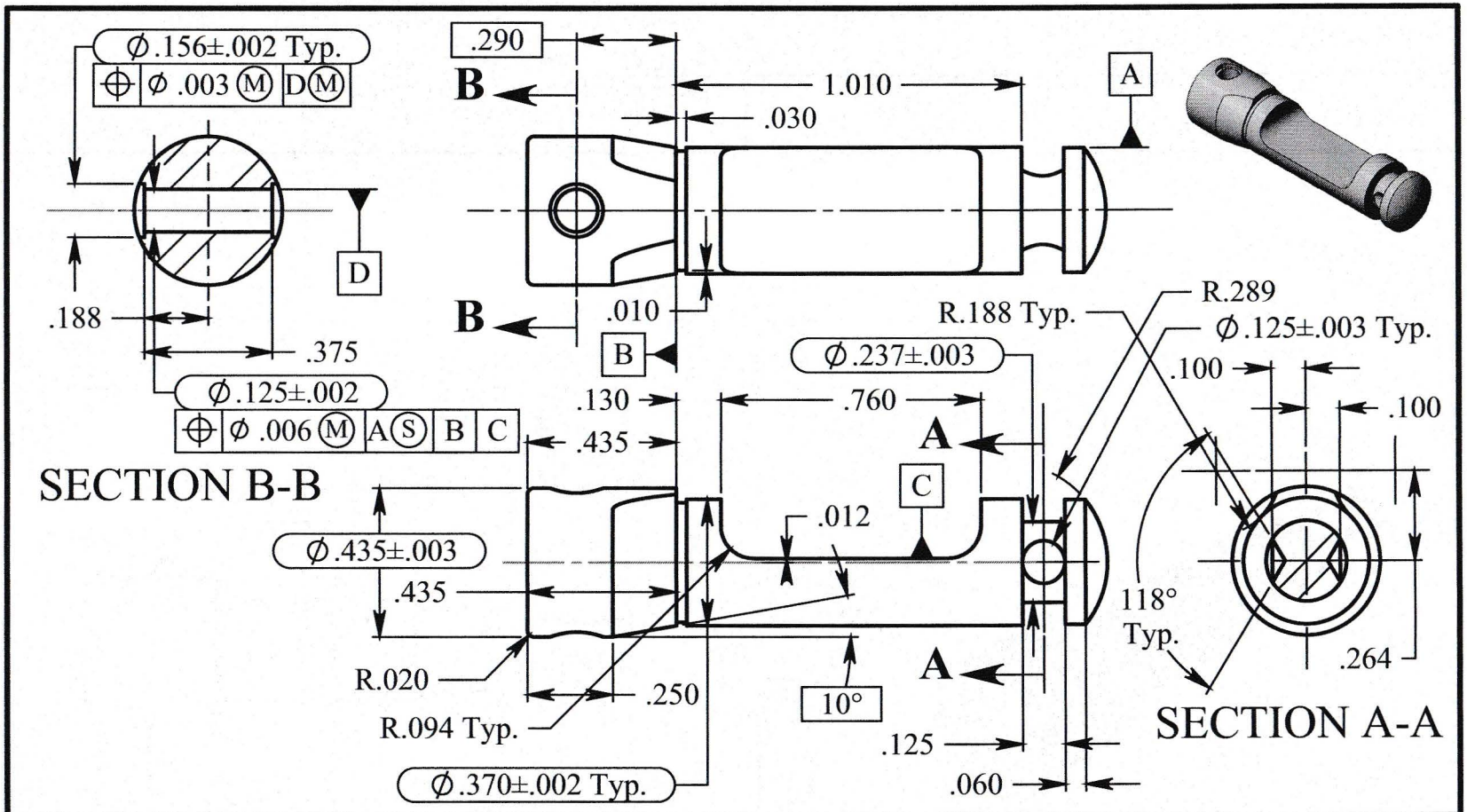
M1A1 Thompson

PART NAME
Rocker Pivot Assembly

OPERATION NAME

OPERATION NO.

SCALE
2:1



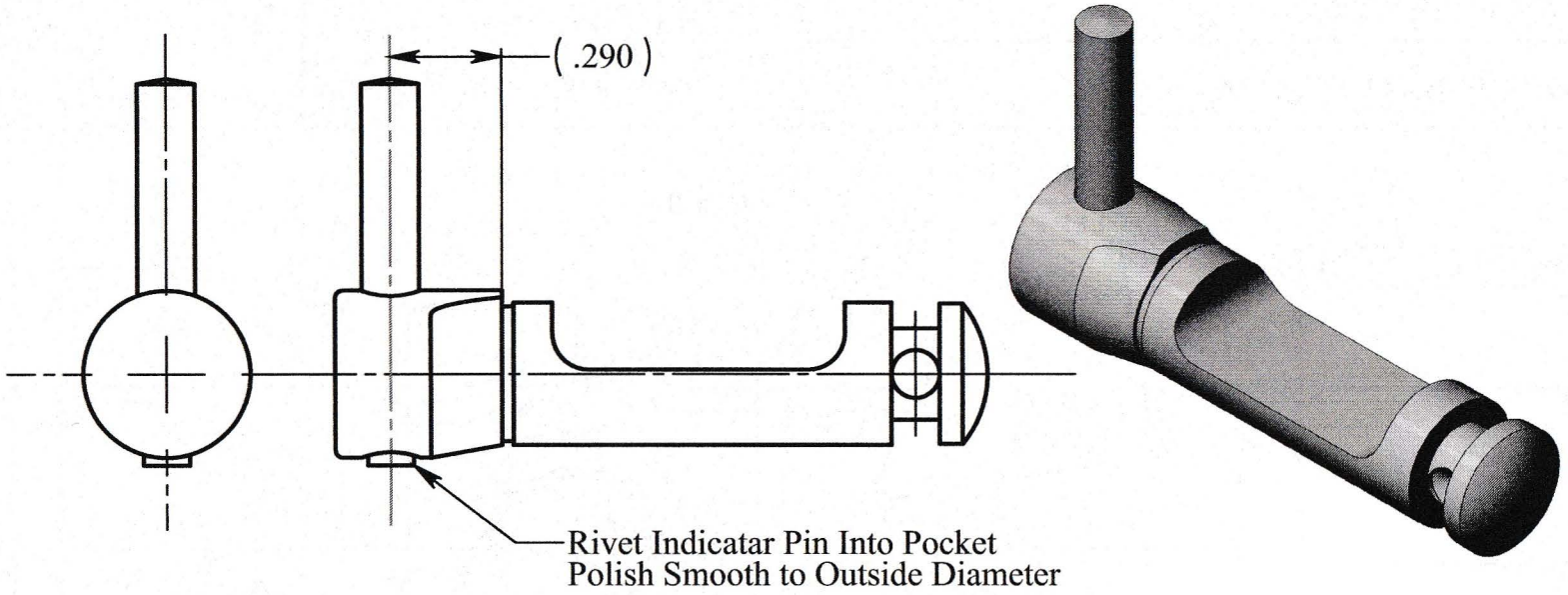
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1215	M1A1 Thompson
HEAT TREAT: Carburize .01 Case	PART NAME: Safety
HARDNESS: HR15N 75 - 80	OPERATION NAME:
FINISH: None	OPERATION NO.: SCALE: 2:1



ITEM NO.	PART NUMBER	QTY.
1	Safety	1
2	Indicator Pin	1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH
Mag. Phosphate

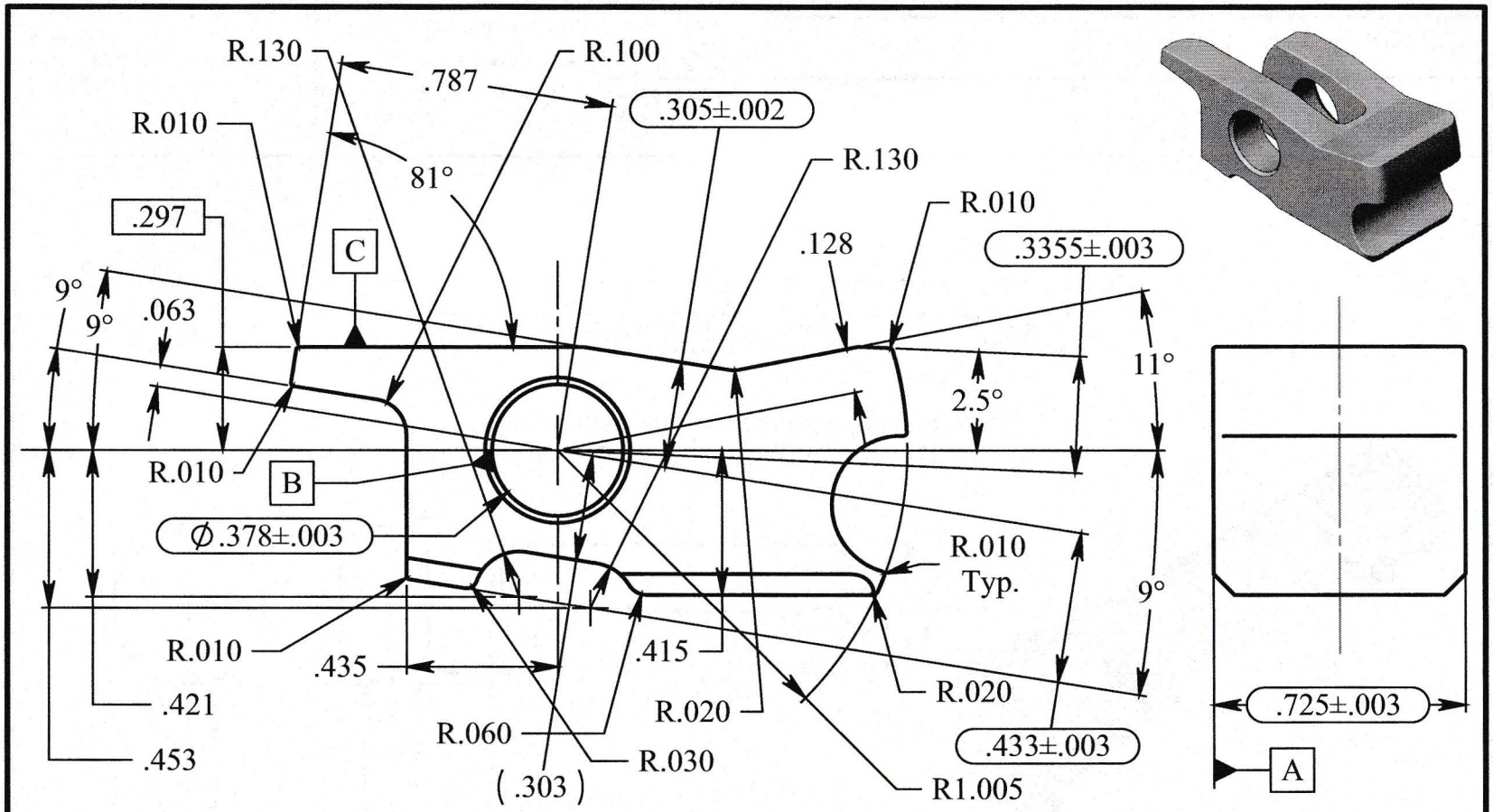
M1A1 Thompson

PART NAME
Safety Lever Assembly

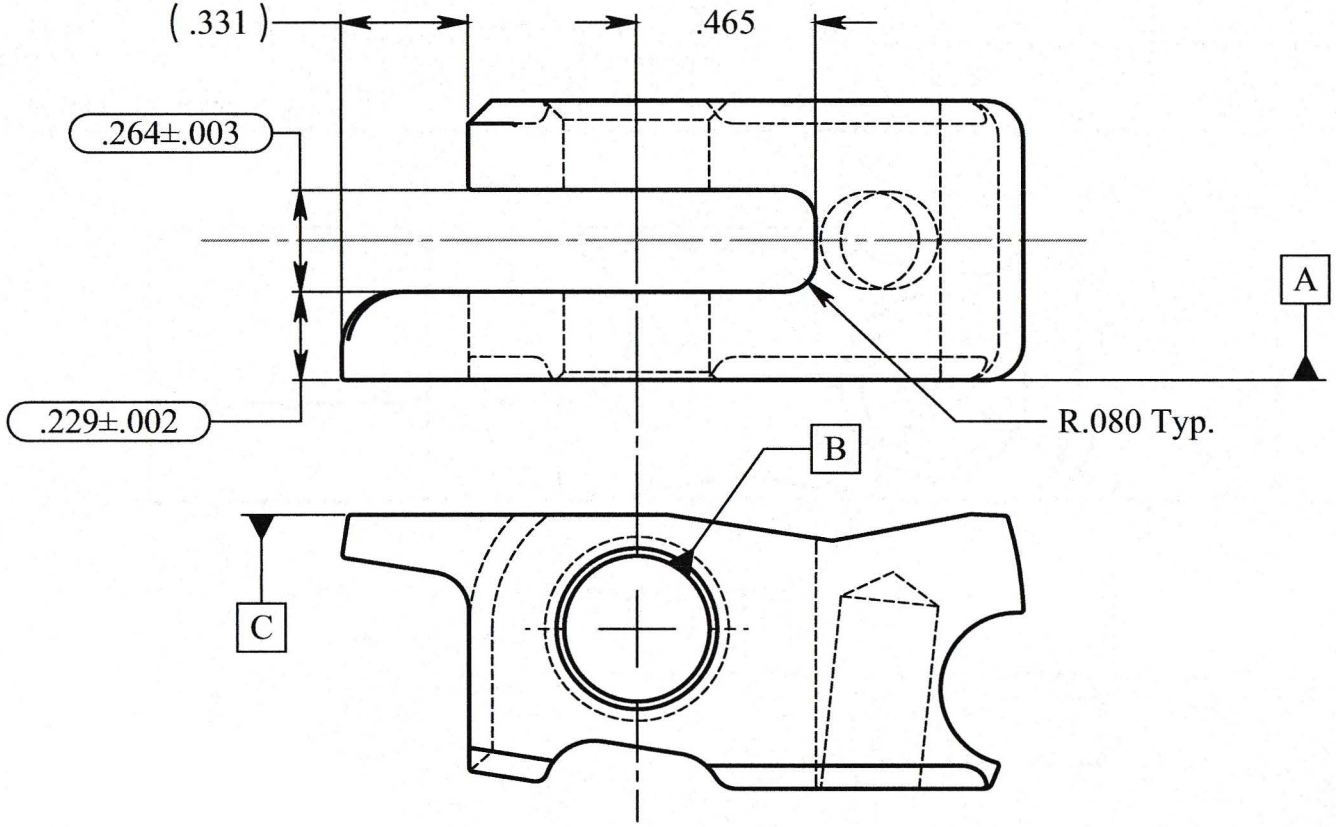
OPERATION NAME

OPERATION NO.

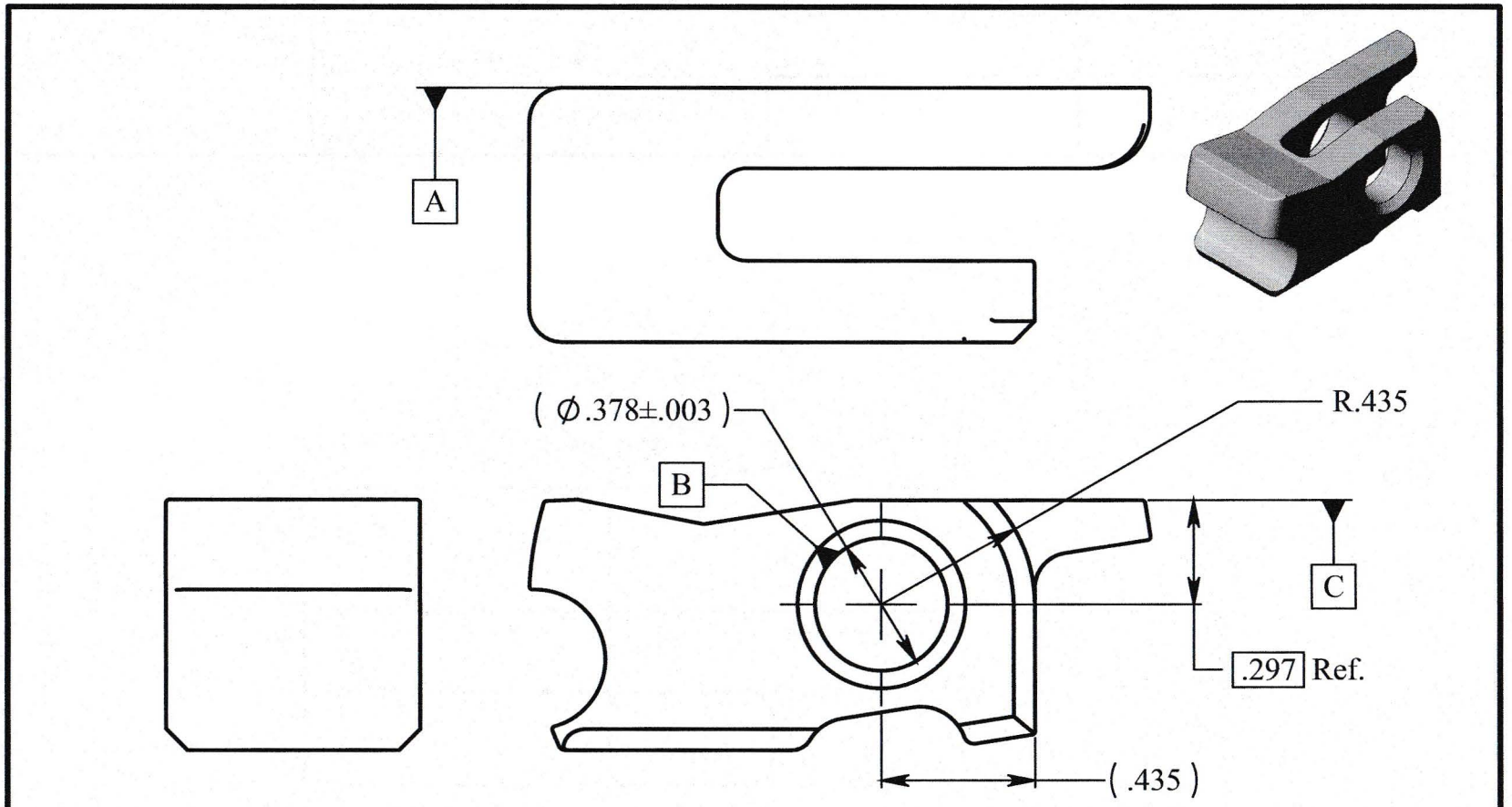
SCALE
2:1



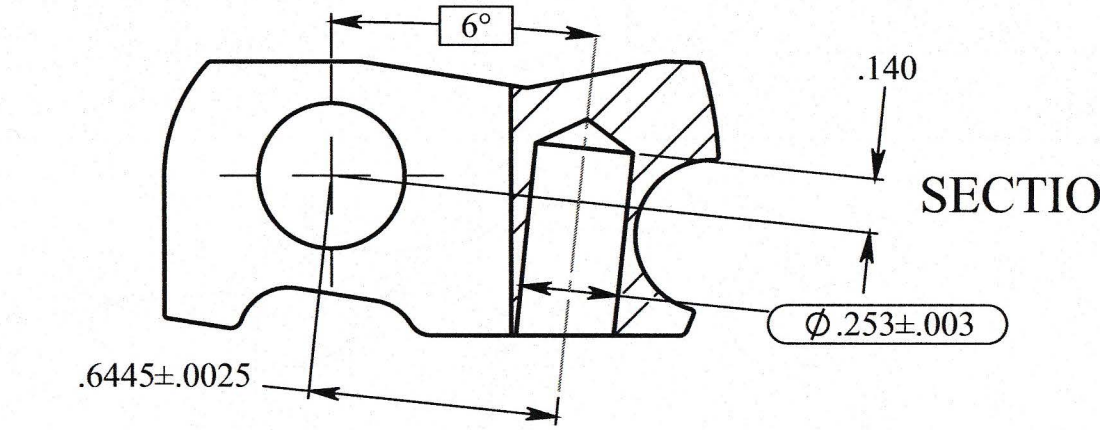
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 4140	M1A1 Thompson
		HEAT TREAT	PART NAME Sear - Drawing 1
		HARDNESS	OPERATION NAME Profile
		FINISH	OPERATION NO. / SCALE 2:1
	Proprietary and Confidential		

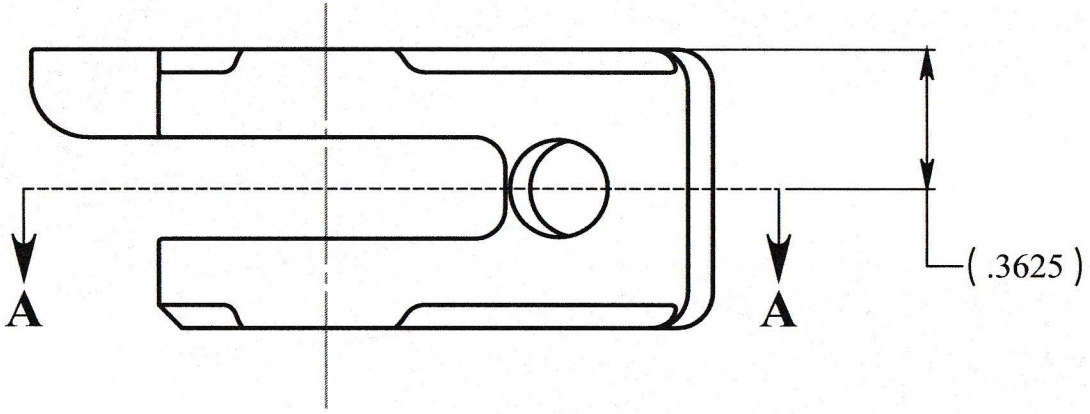


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX Proprietary and Confidential	MATERIAL AISI 4140 HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME Sear - Drawing 2 OPERATION NAME Slot OPERATION NO. SCALE 2:1

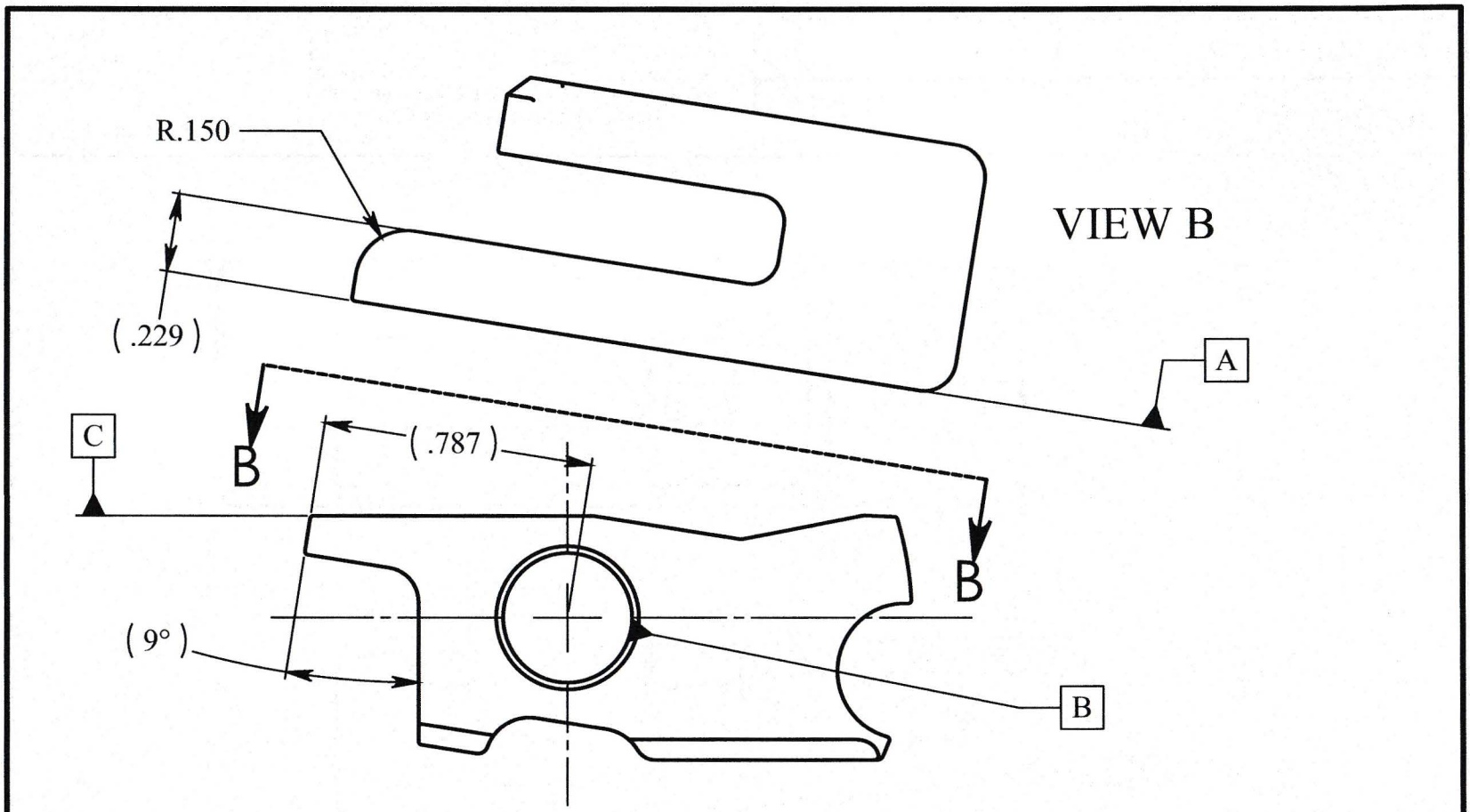


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL AISI 4140	M1A1 Thompson
		HEAT TREAT	PART NAME Sear - Drawing 3
		HARDNESS	OPERATION NAME
	Proprietary and Confidential	FINISH	OPERATION NO. / SCALE 2:1



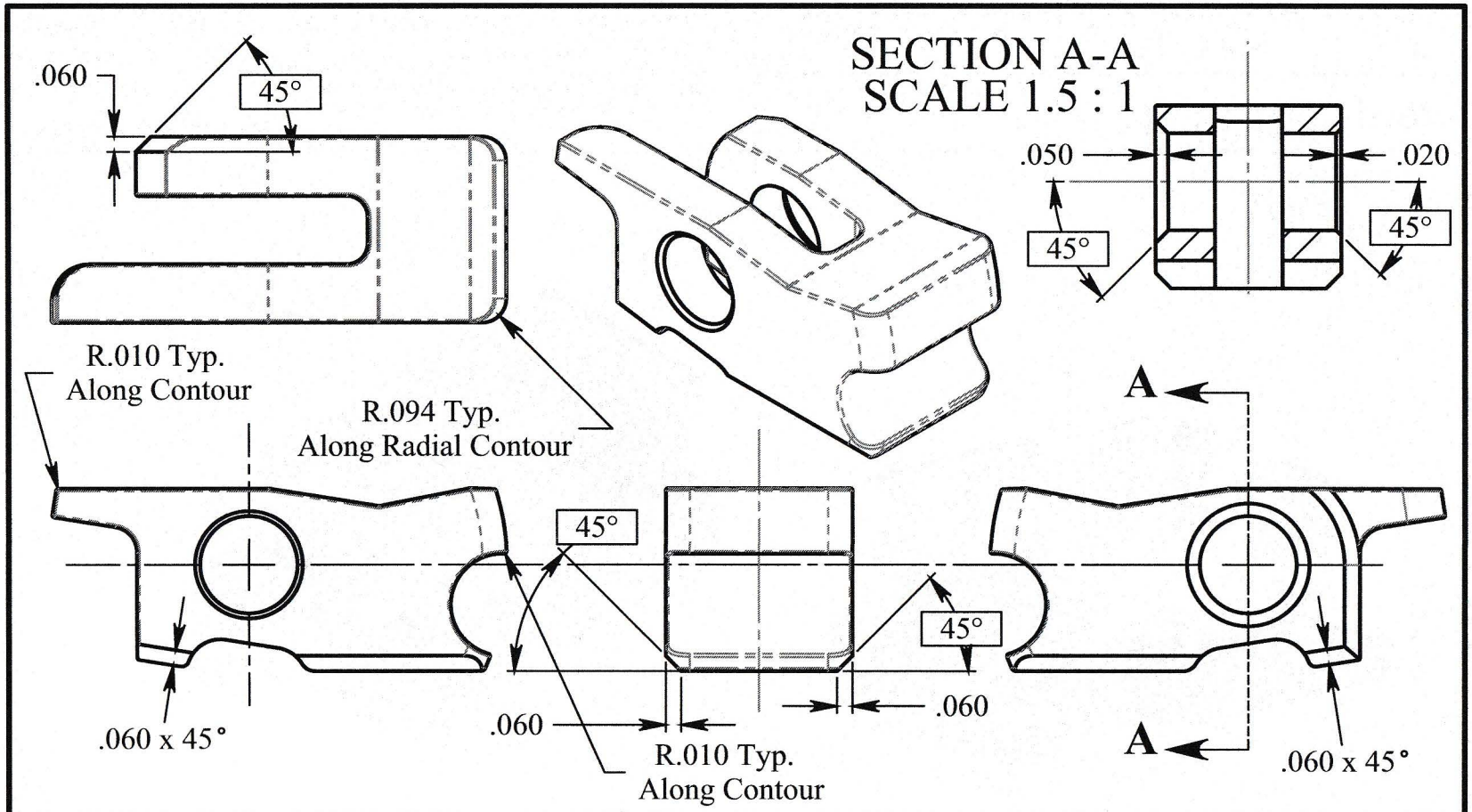


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL: AISI 4140 HEAT TREAT: HARDNESS: FINISH:	M1A1 Thompson PART NAME: Sear - Drawing 4 OPERATION NAME: Spring Hole OPERATION NO.: SCALE: 2:1

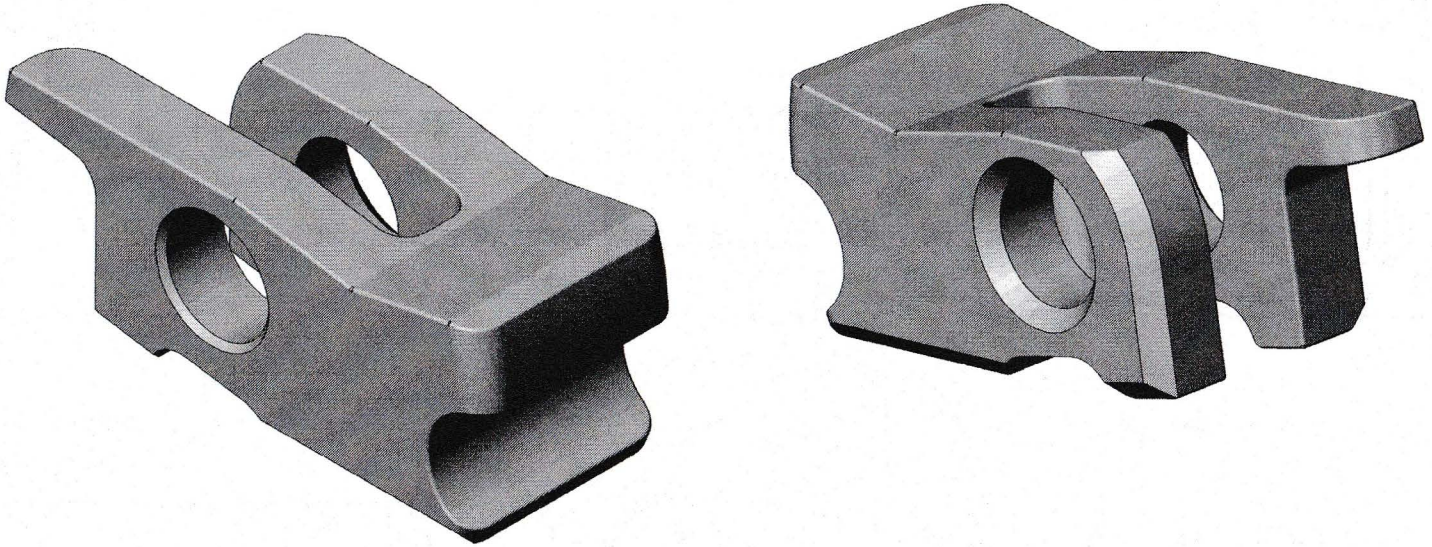


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 4140 HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME Sear - Drawing 5 OPERATION NAME Cam Surface OPERATION NO. SCALE 2:1

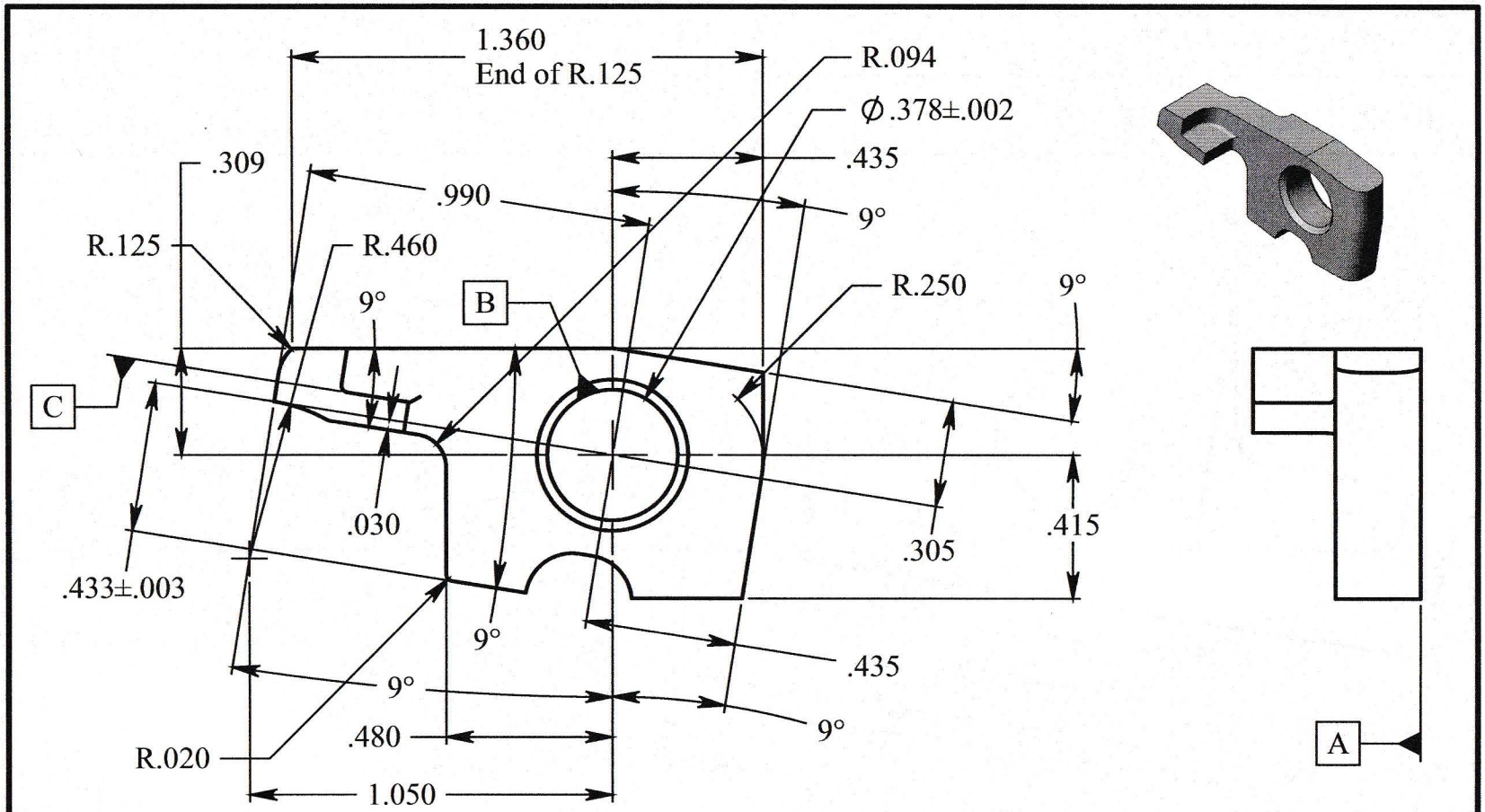
Proprietary and Confidential



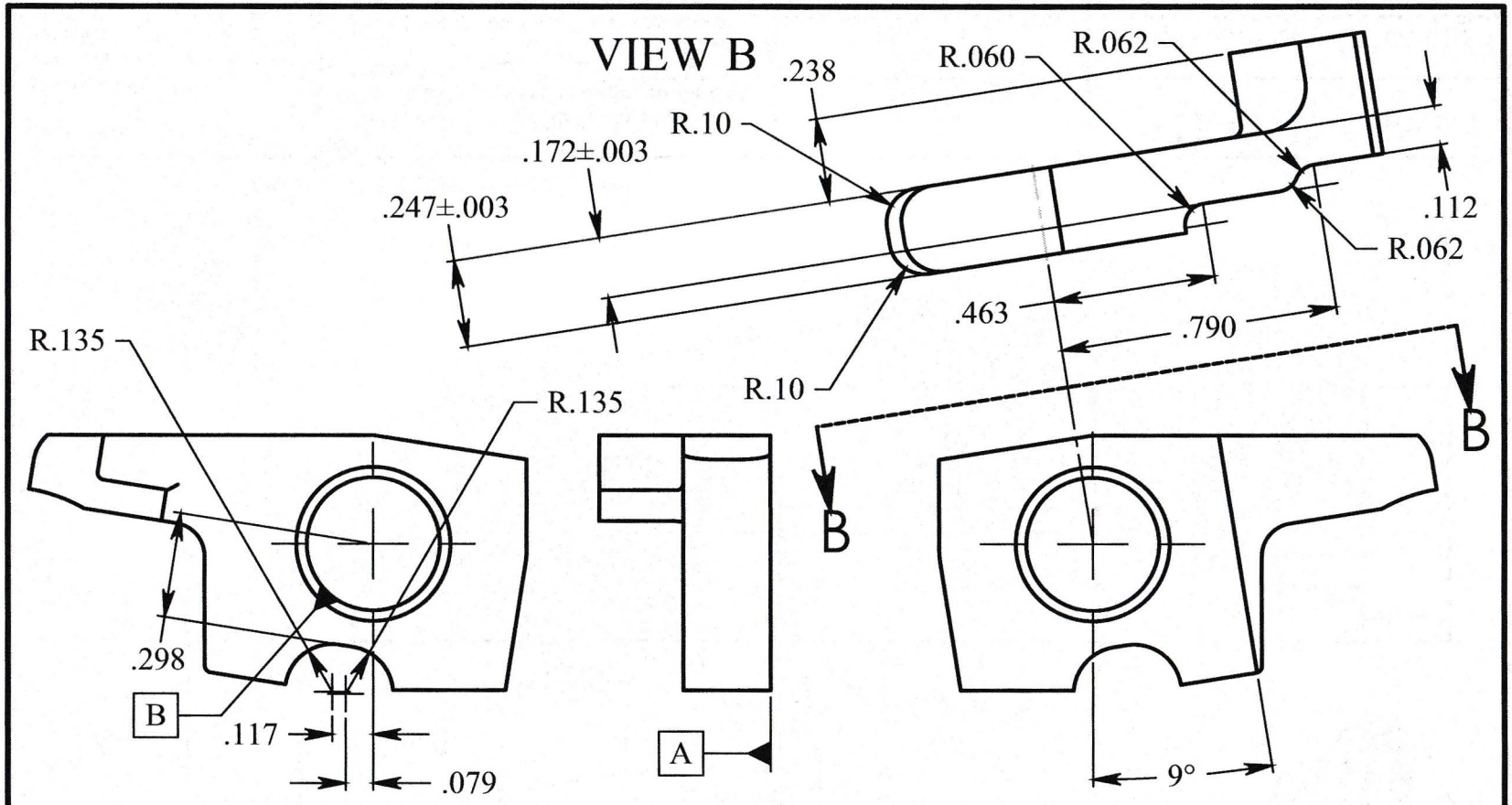
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX	MATERIAL AISI 4140	M1A1 Thompson
		HEAT TREAT	PART NAME Sear - Drawing 6
		HARDNESS	OPERATION NAME Chamfers and Radii
		FINISH	OPERATION NO. / SCALE 3:2
	Proprietary and Confidential		



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX	MATERIAL AISI 4140	M1A1 Thompson
		HEAT TREAT Harden &Temper	PART NAME Sear
		HARDNESS HRC 40 - 45	OPERATION NAME Heat Treat
	Proprietary and Confidential	FINISH Black Oxide	OPERATION NO. 70 SCALE 2:1

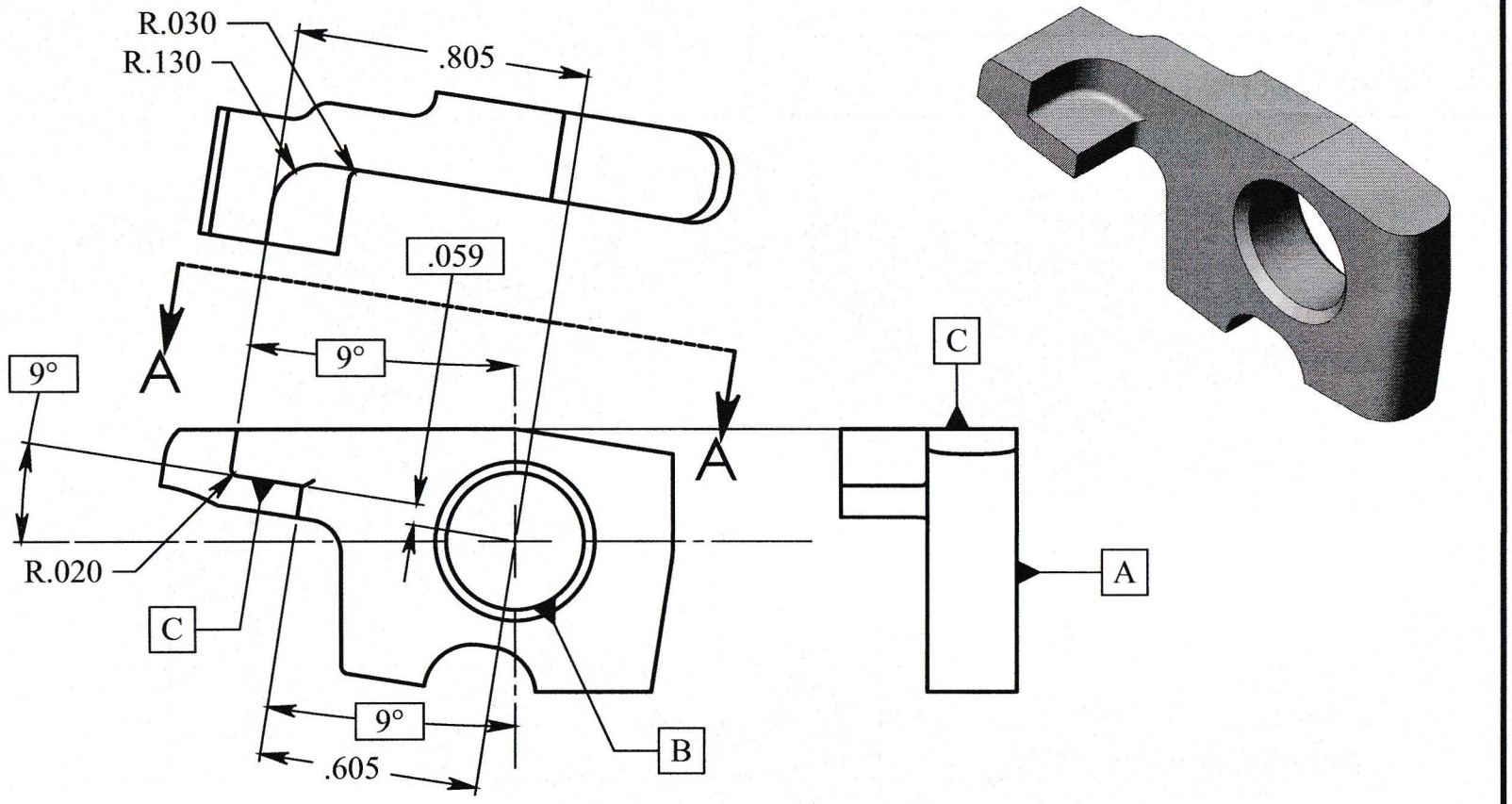


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL AISI 4140 HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME Sear Lever - Drawing 1 OPERATION NAME Profile OPERATION NO. SCALE 2:1

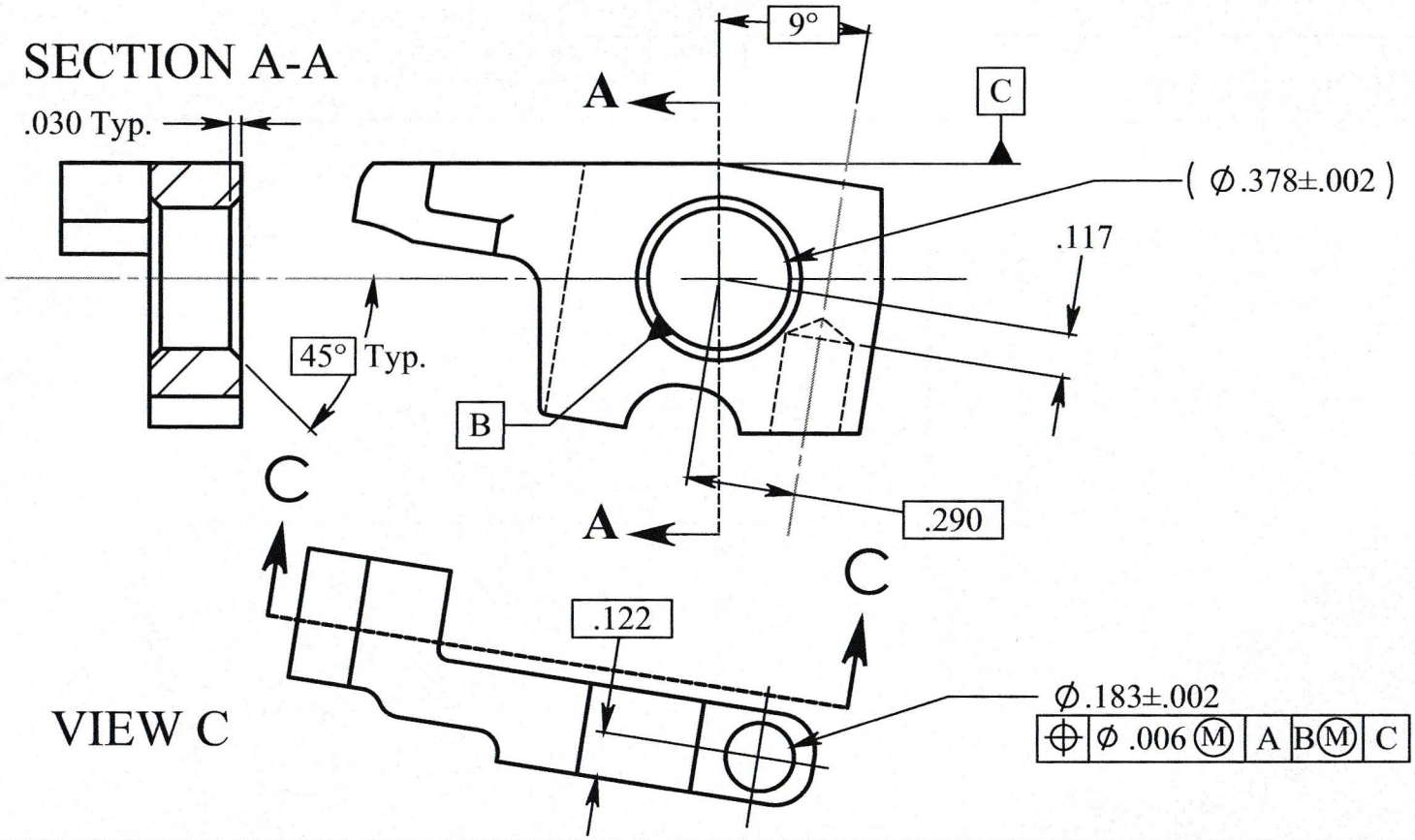


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Sear Lever - Drawing 2
		HARDNESS	OPERATION NAME Clearance Cuts
		FINISH	OPERATION NO. / SCALE 2:1

Proprietary and Confidential



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL	M1A1 Thompson
		HEAT TREAT	PART NAME Sear Lever - Drawing 3
		HARDNESS	OPERATION NAME Cam Surface
	Proprietary and Confidential	FINISH	OPERATION NO. / SCALE 2:1



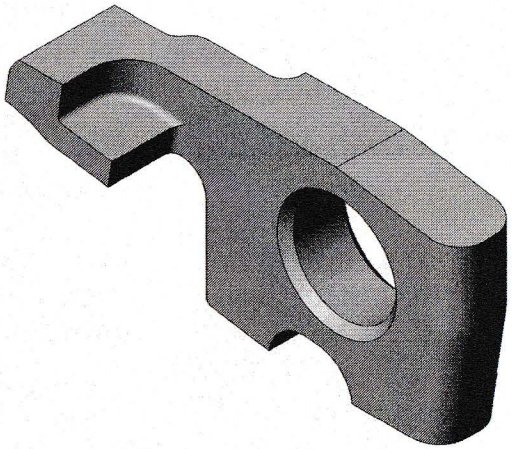
Dimensions are in Inches

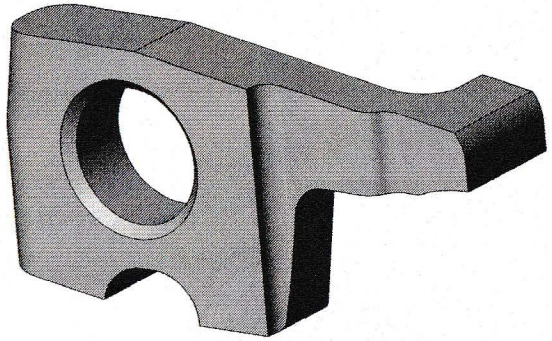
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% C .XXX

Proprietary and Confidential

MATERIAL	M1A1 Thompson
HEAT TREAT	PART NAME: Sear Lever - Drawing 4
HARDNESS	OPERATION NAME: Holes
FINISH	OPERATION NO. / SCALE 2:1





Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 4140	M1A1 Thompson
		HEAT TREAT Harden &Temper	PART NAME Sear Lever - Drawing 5
		HARDNESS HRC 45 - 50	OPERATION NAME Heat Treat
		FINISH Black Oxide	OPERATION NO. / SCALE 2:1
	Proprietary and Confidential		

Manufaturing Data:

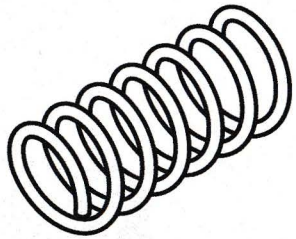
Spring Type:	Helical Compression
Outside Diameter:	.170
Wire Diameter:	.030
Total Coils:	6.5
Active Coils:	6.5
Coil Type:	Open, Not Ground
Free Length:	.430
Wind Direction:	Either Hand

Inspection Data:

Load Length L1:	.310 inches
Load P1:	7.8 +/- 1.5 lbs.
Load Length L2:	.280 inches
Loap P2:	9.75 lbs +/- 1.7 lbs.
Max. Solid Height:	.240 inches
Spring works in a:	.180 diameter hole
Spring works over:	.000 diameter rod

Engineering Data:

Spring Rate:	65.3 lbs/in.
Spring Index:	4.7
Static Solid Stress:	176,700 psi
Stress Percentage: at Solid Height	71%



Expand the last end coil on one end to an outside diameter of .205 +/-.005

Dimensions are in Inches

Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:

1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX

2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: Music Wire (ASTM A228)	M1A1 Thompson
HEAT TREAT: Stress Relieve	PART NAME: Sear Lever Spring
HARDNESS	OPERATION NAME
FINISH	OPERATION NO. / SCALE: 4:1

Manufaturing Data:

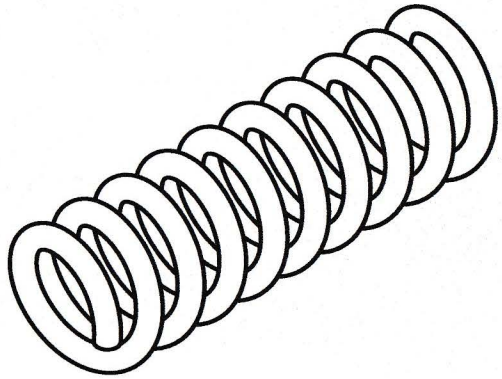
Spring Type:	Helical Compression
Outside Diameter:	.227 inches
Wire Diameter:	.035
Total Coils:	9.5
Active Coils:	9.5
Coil Type:	Open, Not Ground
Free Length:	.750
Wind Direction:	Either Hand

Inspection Data:

Load Length L1:	.560 inches
Load P1:	6.1 +/-1.4 lbs.
Load Length L2:	.500 inches
Loap P2:	8.0 lbs +/-1.4 lbs.
Max. Solid Height:	.375 inches
Spring works in a:	.250 diameter hole
Spring works over:	.00 diameter rod

Engineering Data:

Spring Rate:	32.1 lbs/in.
Spring Index:	5.5
Static Solid Stress:	140,000 psi
Stress Percentage: at Solid Height	55.4%



Expand the last end coil on one end to an outside diameter of .270 +/-.005

Dimensions are in Inches

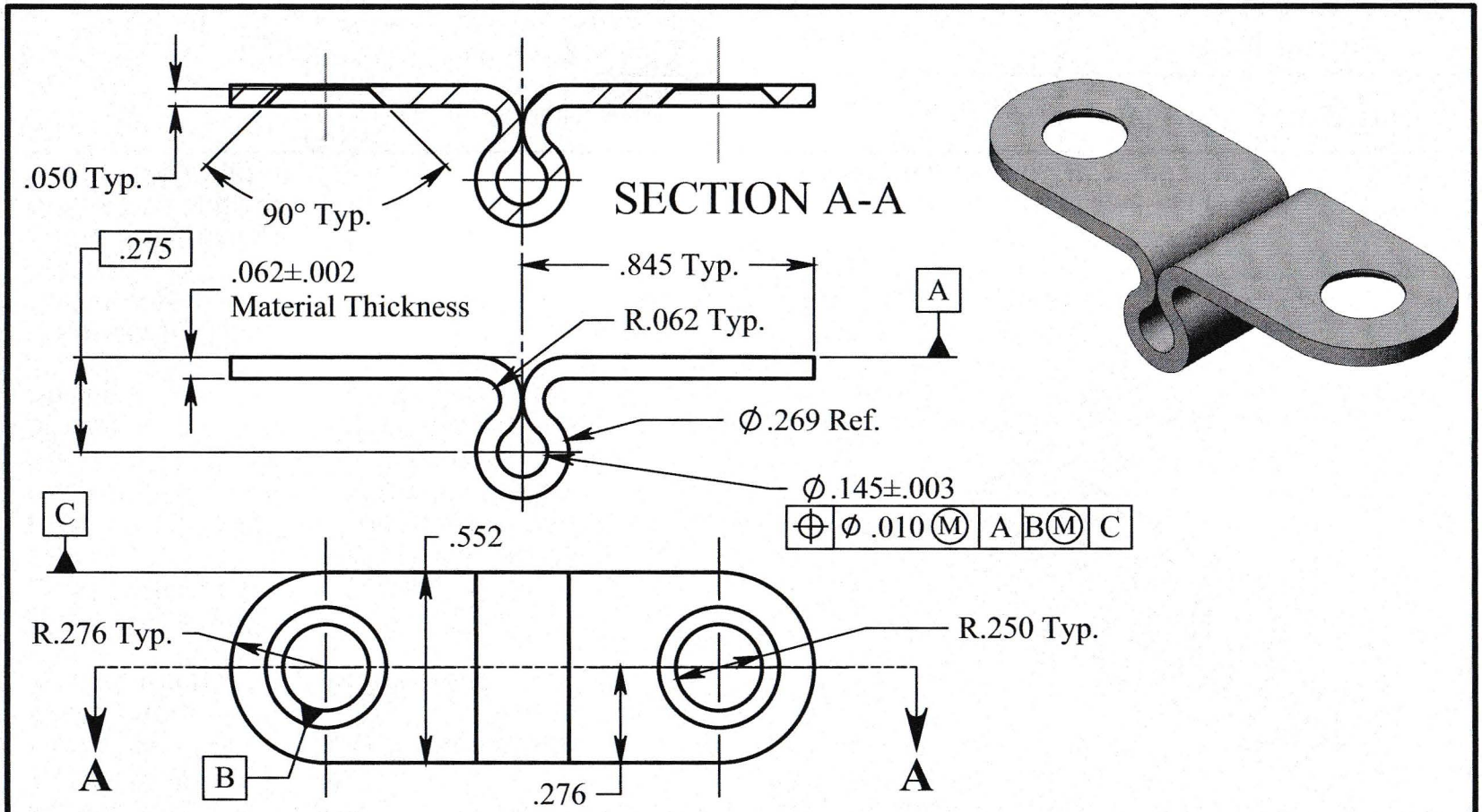
Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)

Proprietary and Confidential

MATERIAL: Music Wire (ASTM A228)	M1A1 Thompson	
HEAT TREAT: Stress Relieve	PART NAME: Sear Spring	
HARDNESS	OPERATION NAME	
FINISH	OPERATION NO.	SCALE: 4:1



Dimensions are in Inches

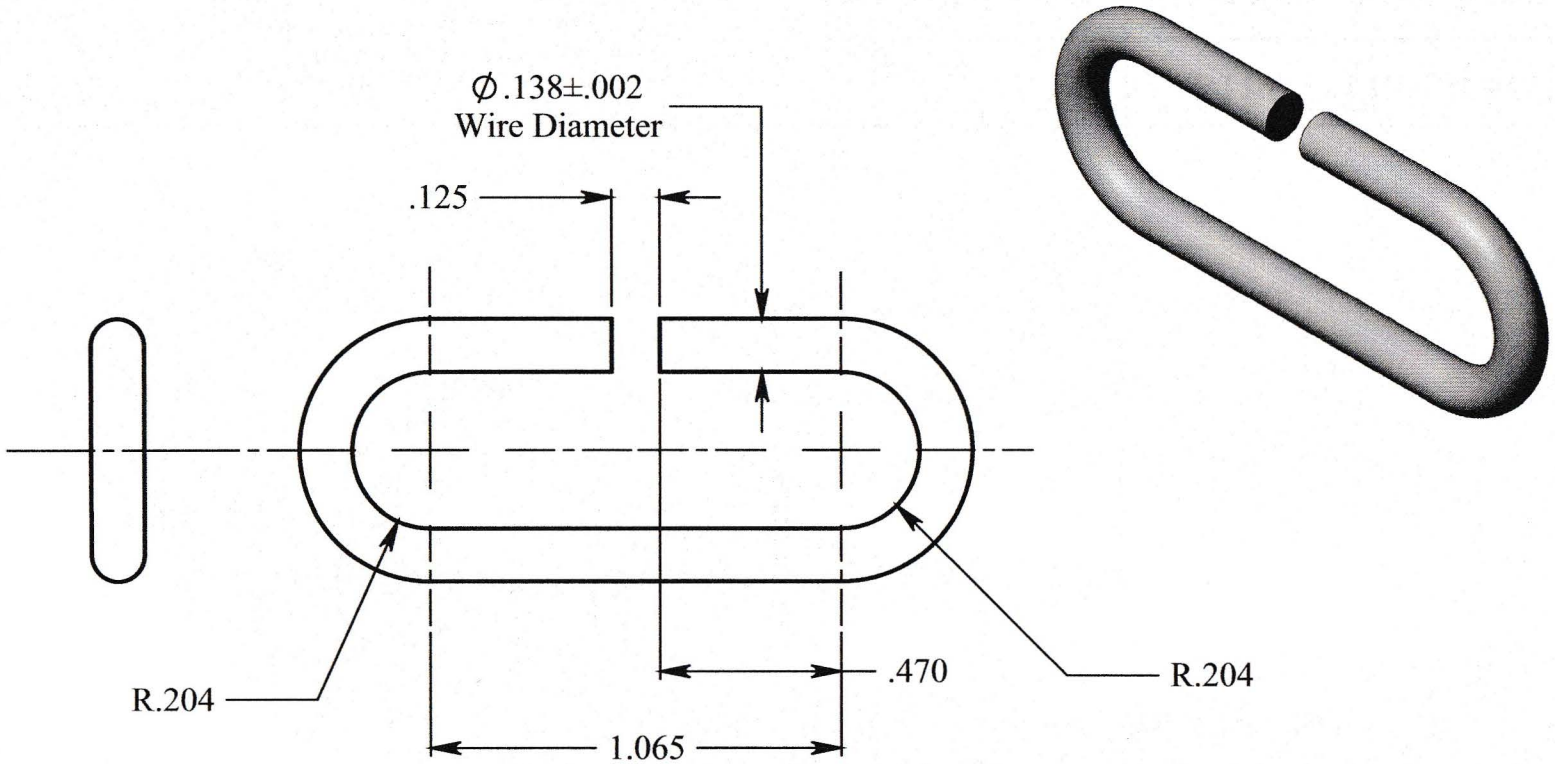
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

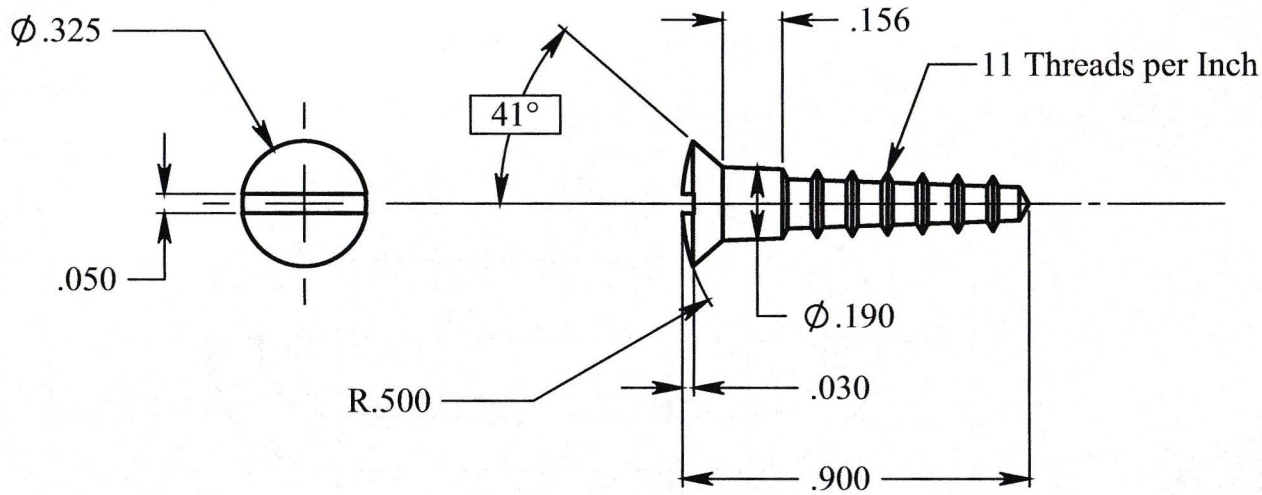
Proprietary and Confidential

MATERIAL: AISI 1010	M1A1 Thompson
HEAT TREAT	PART NAME: Sling Swivel Base
HARDNESS	OPERATION NAME
FINISH: Mag. Phosphate	OPERATION NO. / SCALE: 2:1

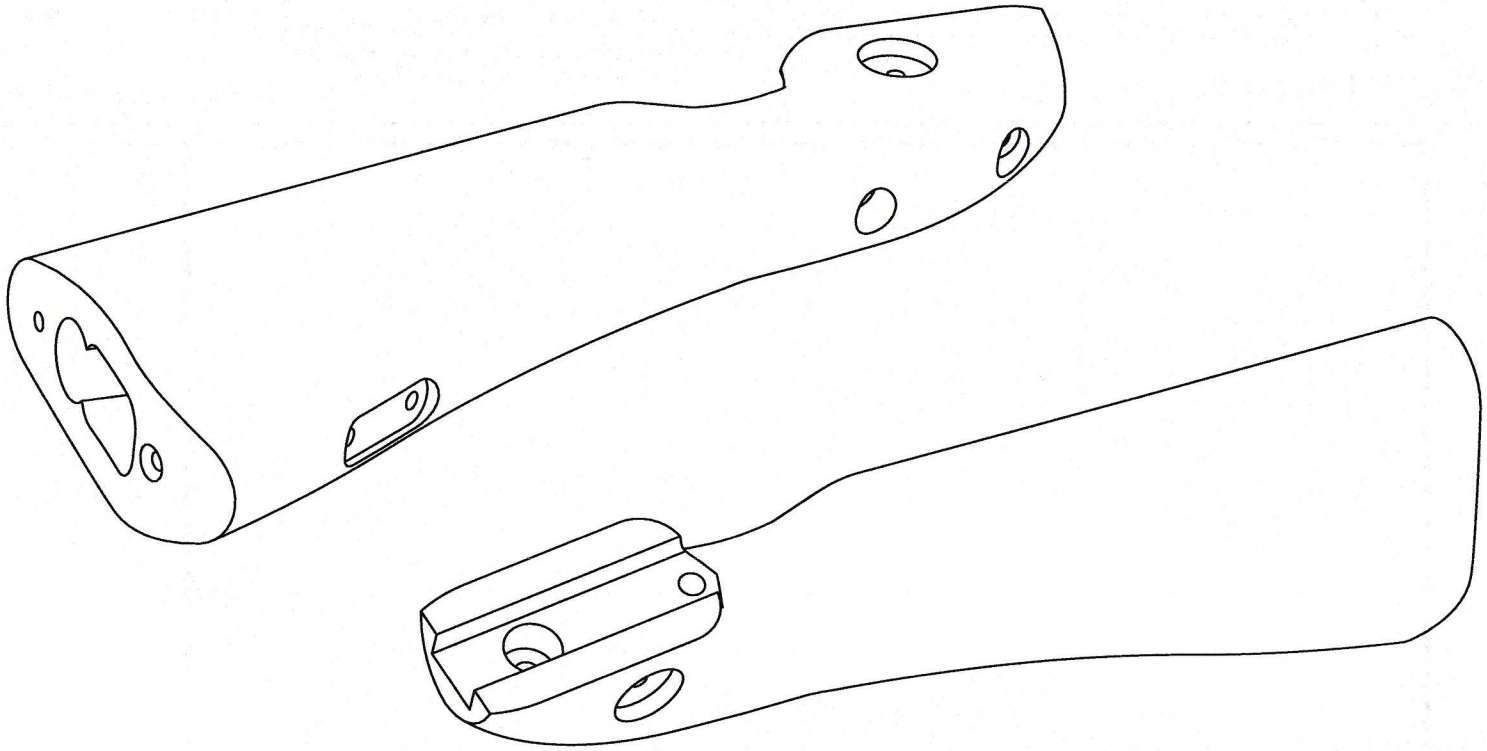
276



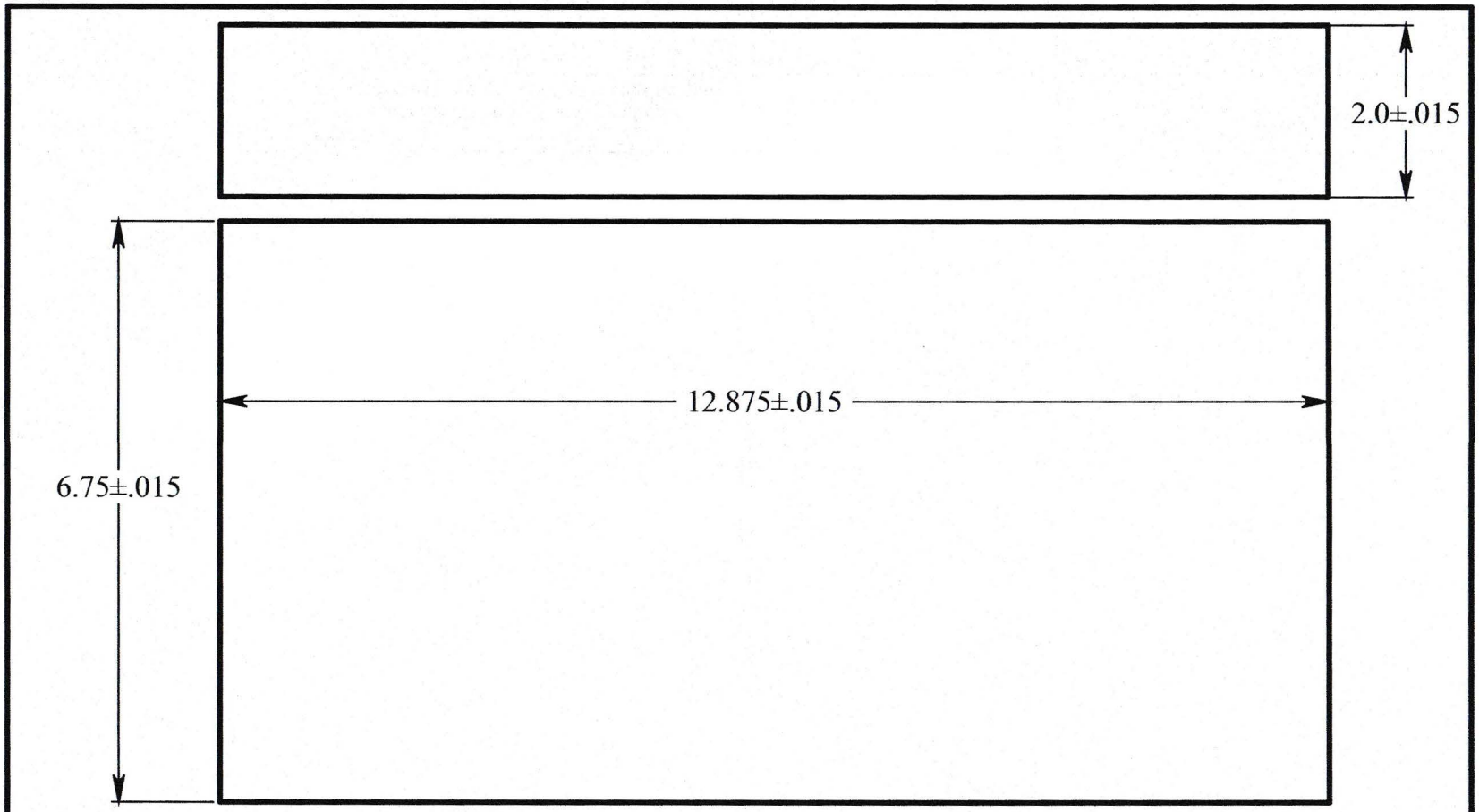
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)	MATERIAL AISI 1095	M1A1 Thompson
		HEAT TREAT	PART NAME Sling Swivel Loop
		HARDNESS	OPERATION NAME
		FINISH Black Oxide	OPERATION NO. / SCALE 2:1
	Proprietary and Confidential		



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 4140	M1A1 Thompson
		HEAT TREAT Quench &Temper	PART NAME Sling Swivel Ret. Screw
		HARDNESS HRC 24-32	OPERATION NAME
		FINISH None	OPERATION NO. / SCALE 2:1
	Proprietary and Confidential		



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL Walnut	M1A1 Thompson	
		HEAT TREAT	PART NAME Stock	
		HARDNESS	OPERATION NAME	
		FINISH	OPERATION NO.	SCALE 1:2
	Proprietary and Confidential			



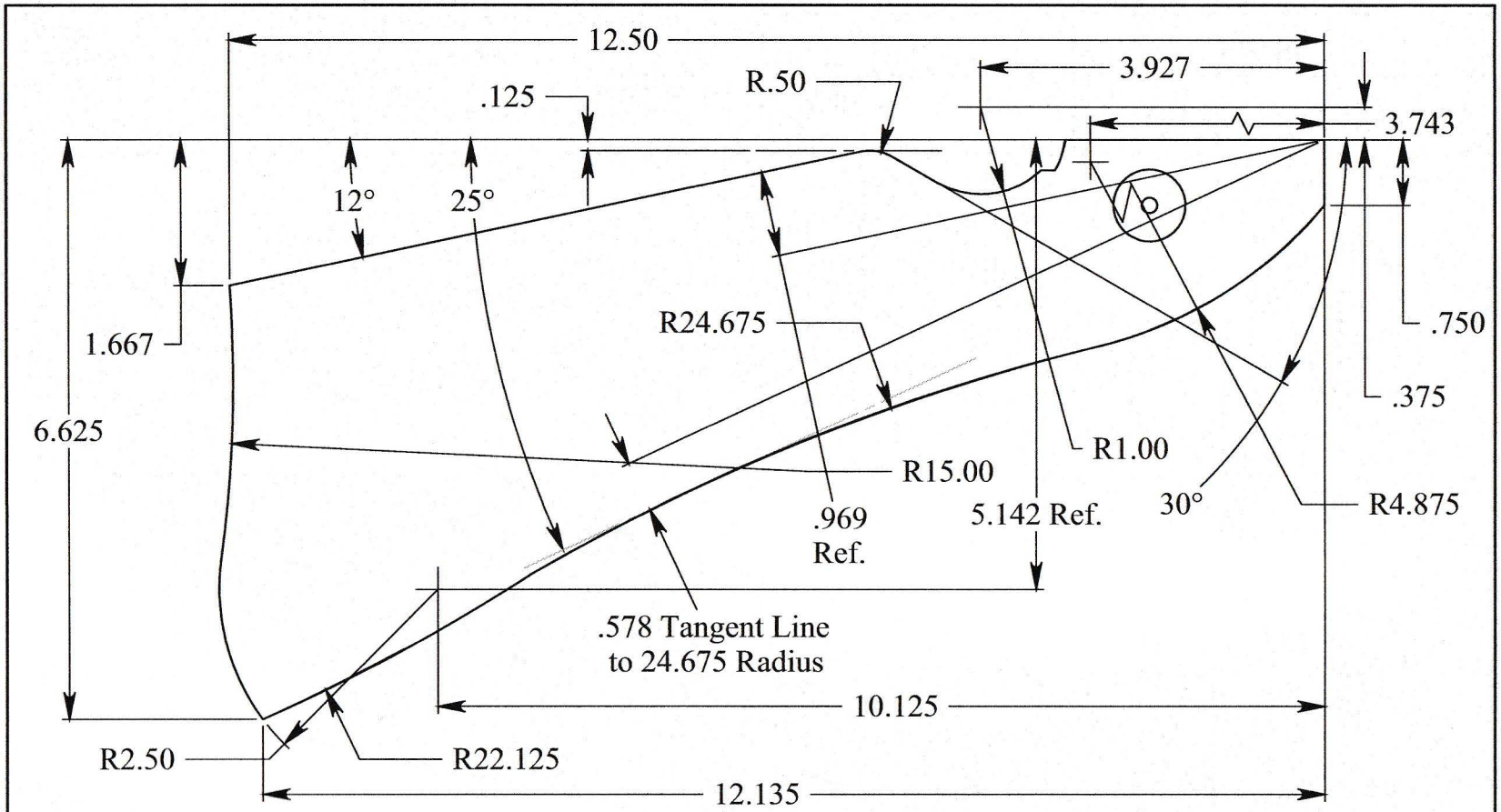
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

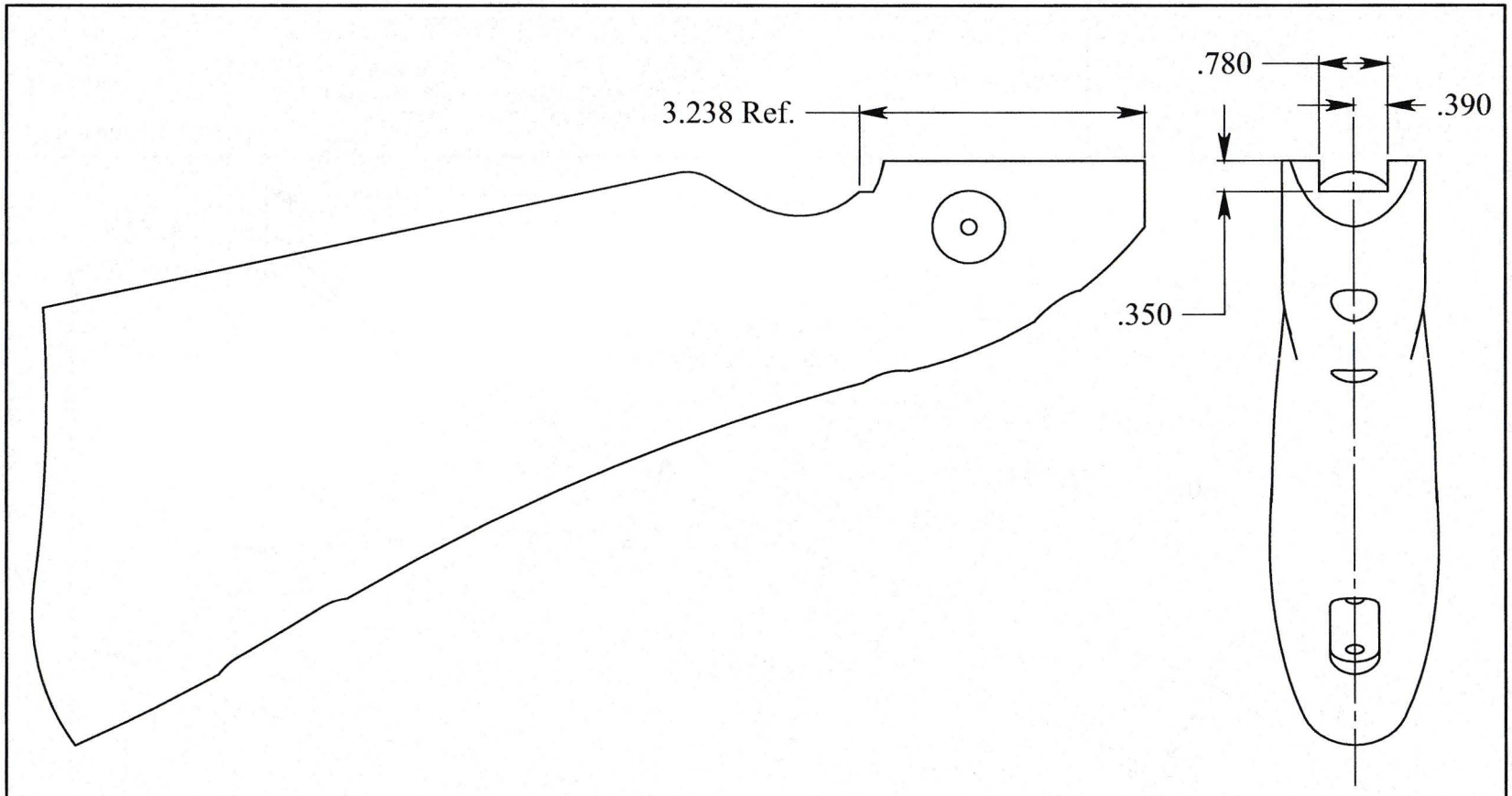
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: Walnut	M1A1 Thompson
HEAT TREAT	PART NAME: Stock
HARDNESS	OPERATION NAME: Stock Blank
FINISH	OPERATION NO.: 10 / SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL: Walnut HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Stock OPERATION NAME: Side Profile OPERATION NO.: 20 SCALE: 1:2



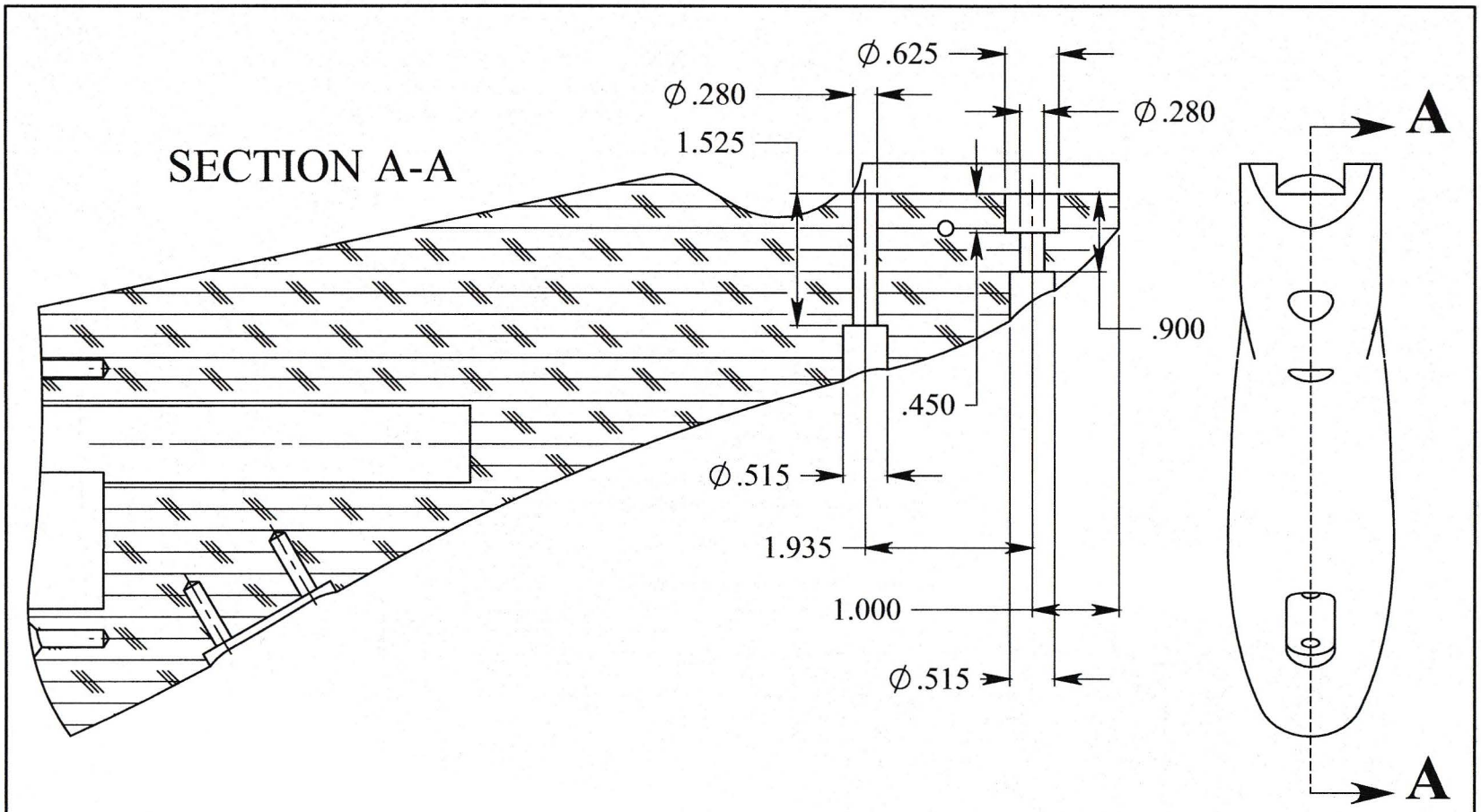
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

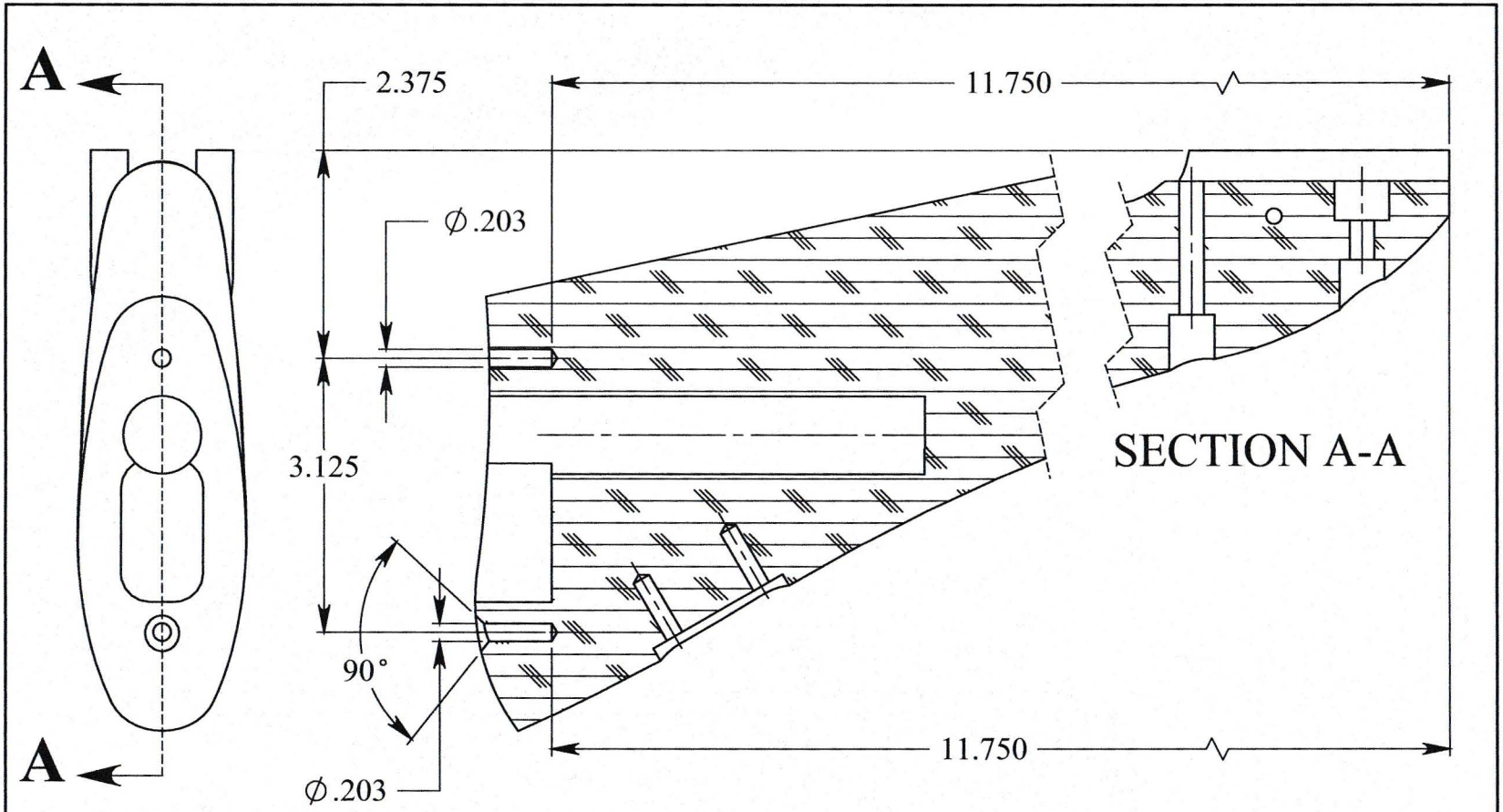
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: Walnut	M1A1 Thompson
HEAT TREAT	PART NAME: Stock
HARDNESS	OPERATION NAME: Frame Cut
FINISH	OPERATION NO.: 30
	SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX) Proprietary and Confidential	MATERIAL: Walnut HEAT TREAT: HARDNESS: FINISH:	M1A1 Thompson PART NAME: Stock OPERATION NAME: Attachment Holes OPERATION NO.: 40 SCALE: 1:2



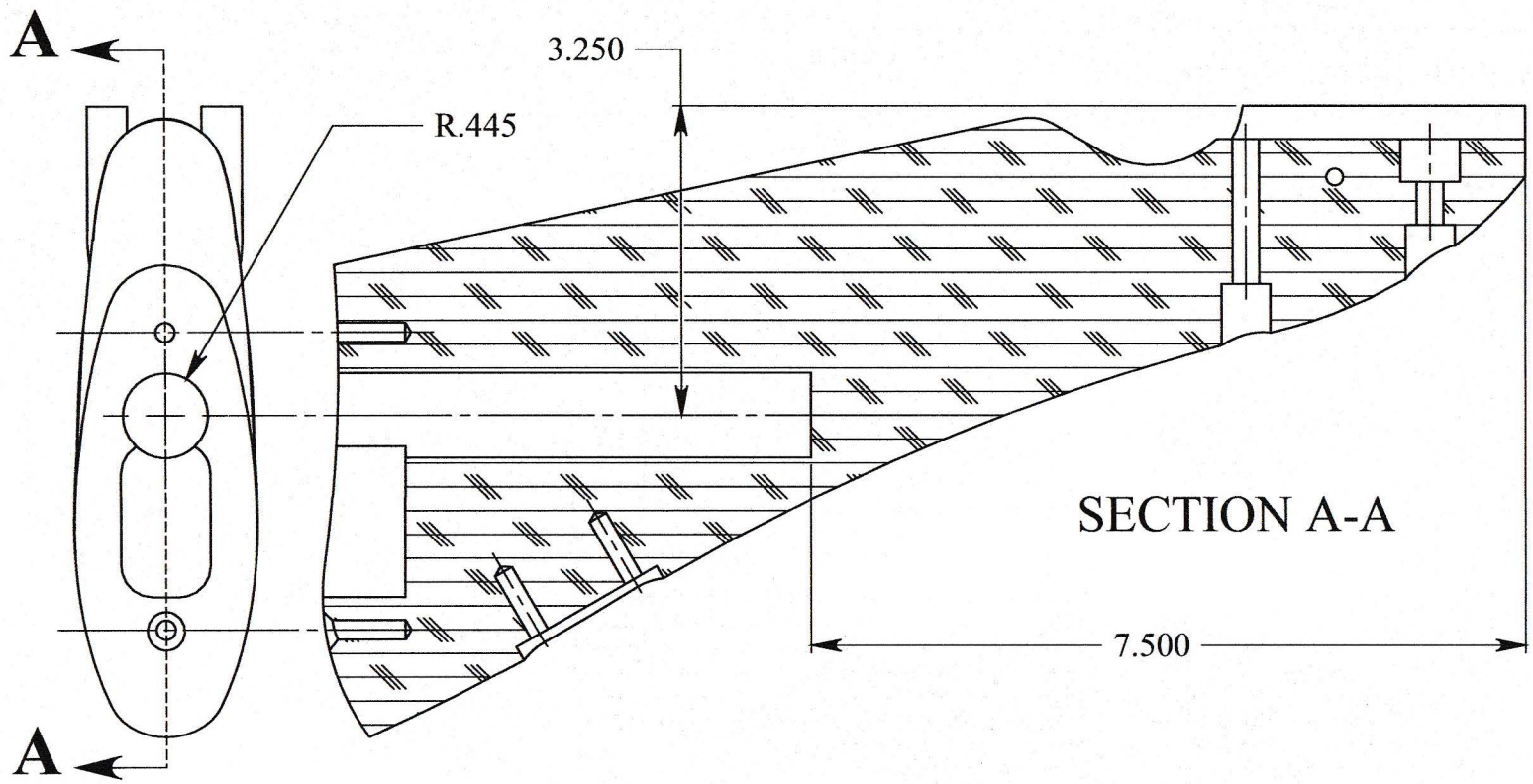
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

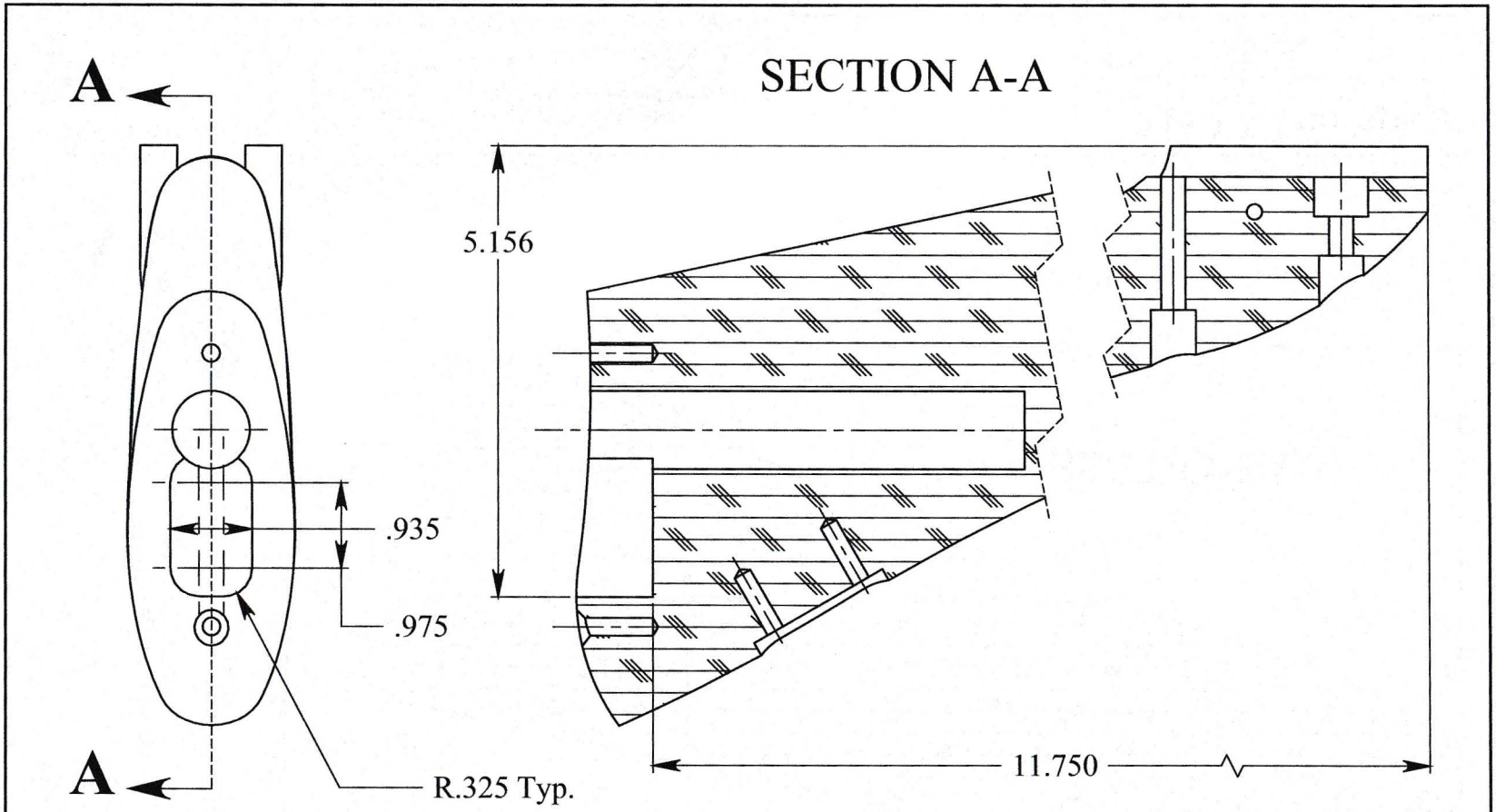
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX

Proprietary and Confidential

MATERIAL: Walnut	M1A1 Thompson
HEAT TREAT	PART NAME: Stock
HARDNESS	OPERATION NAME: Butt Plate Holes
FINISH	OPERATION NO.: 50
	SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL: Walnut HEAT TREAT: HARDNESS: FINISH:	M1A1 Thompson PART NAME: Stock OPERATION NAME: Oiler Hole OPERATION NO.: 60 SCALE: 1:2
	Proprietary and Confidential		



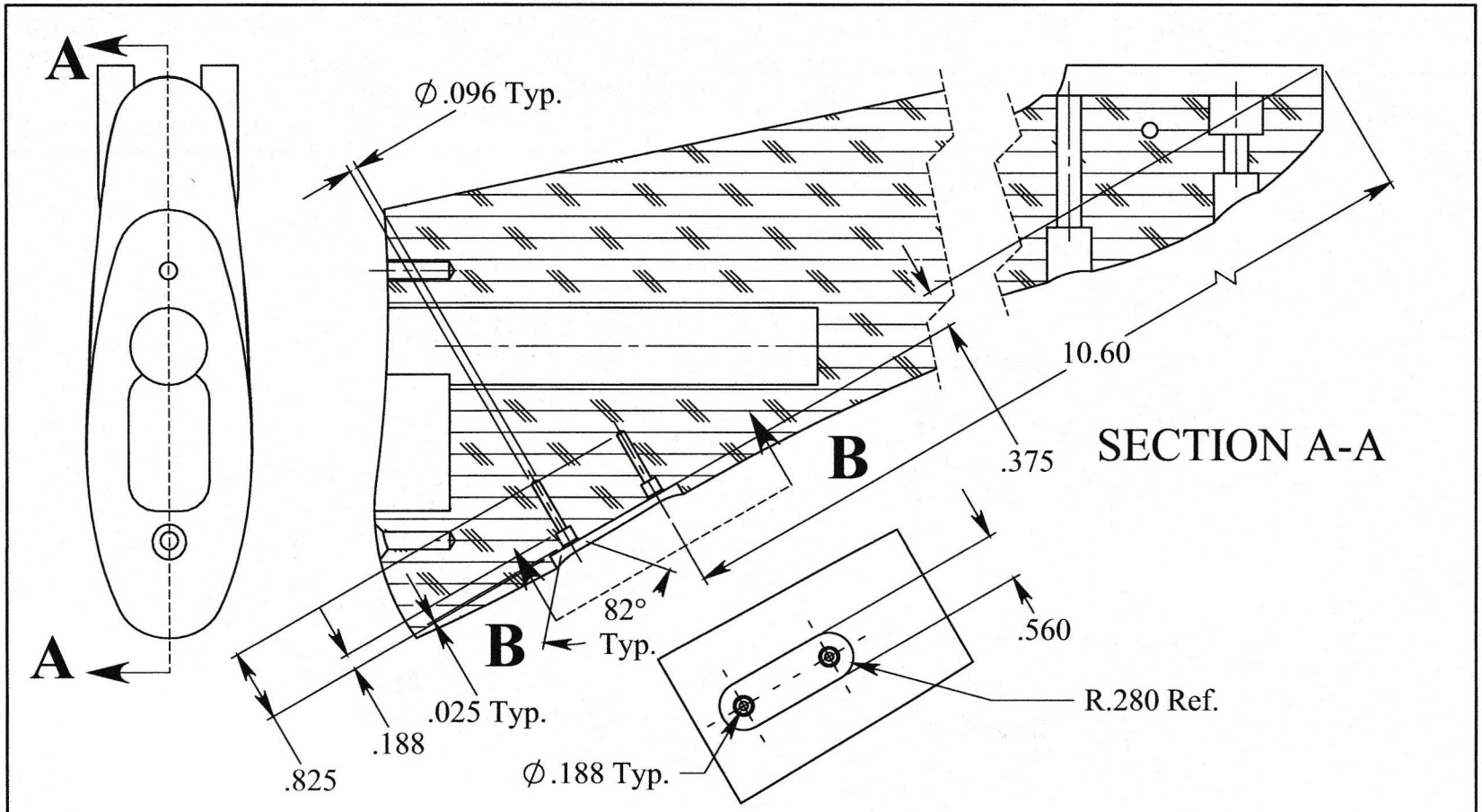
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

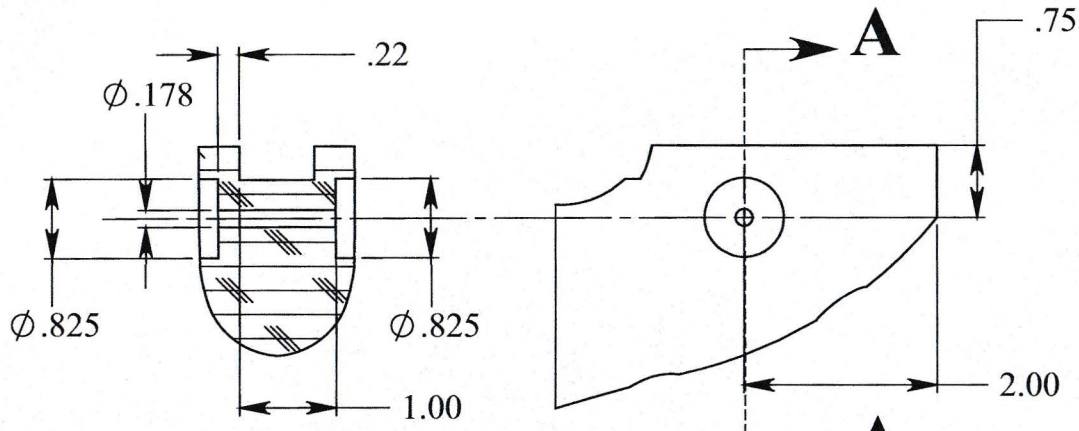
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: Walnut	M1A1 Thompson
HEAT TREAT	PART NAME: Stock
HARDNESS	OPERATION NAME: Slot
FINISH	OPERATION NO.: 70
	SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)	MATERIAL Walnut	M1A1 Thompson	
		HEAT TREAT	PART NAME Stock	
		HARDNESS	OPERATION NAME Sling Swivel	
		FINISH	OPERATION NO. 80	SCALE 1:2
	Proprietary and Confidential			



SECTION A-A

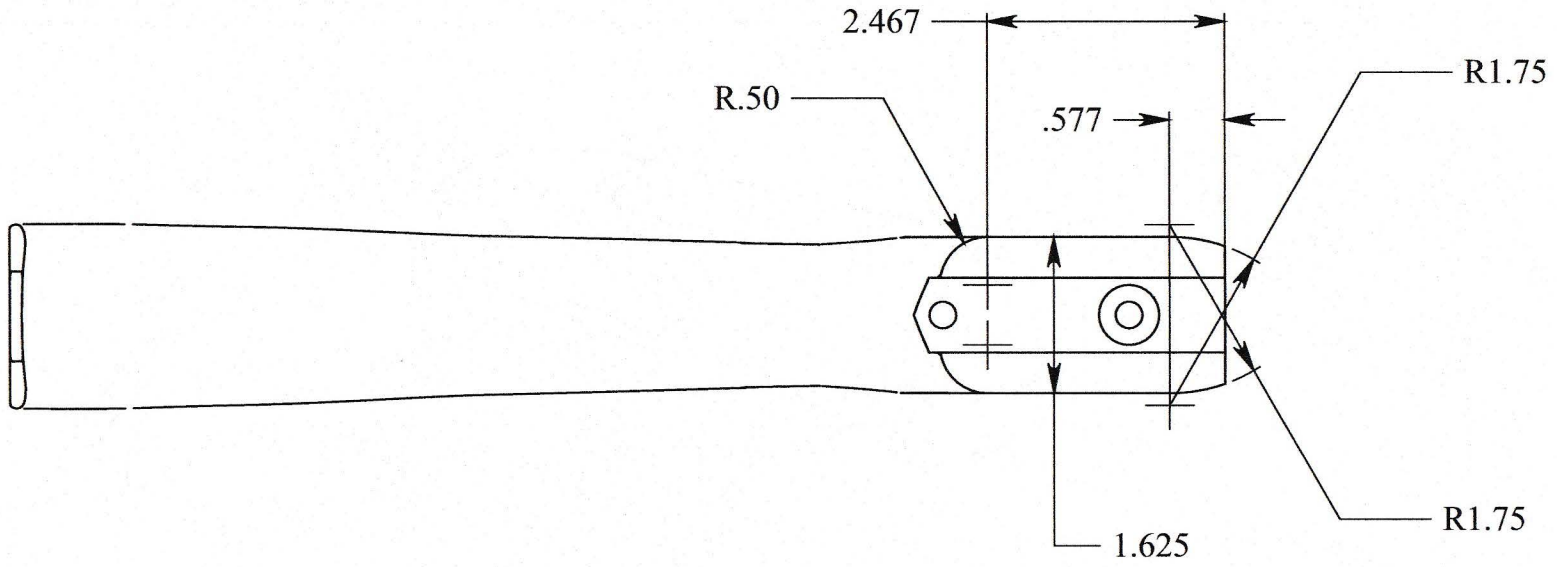
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

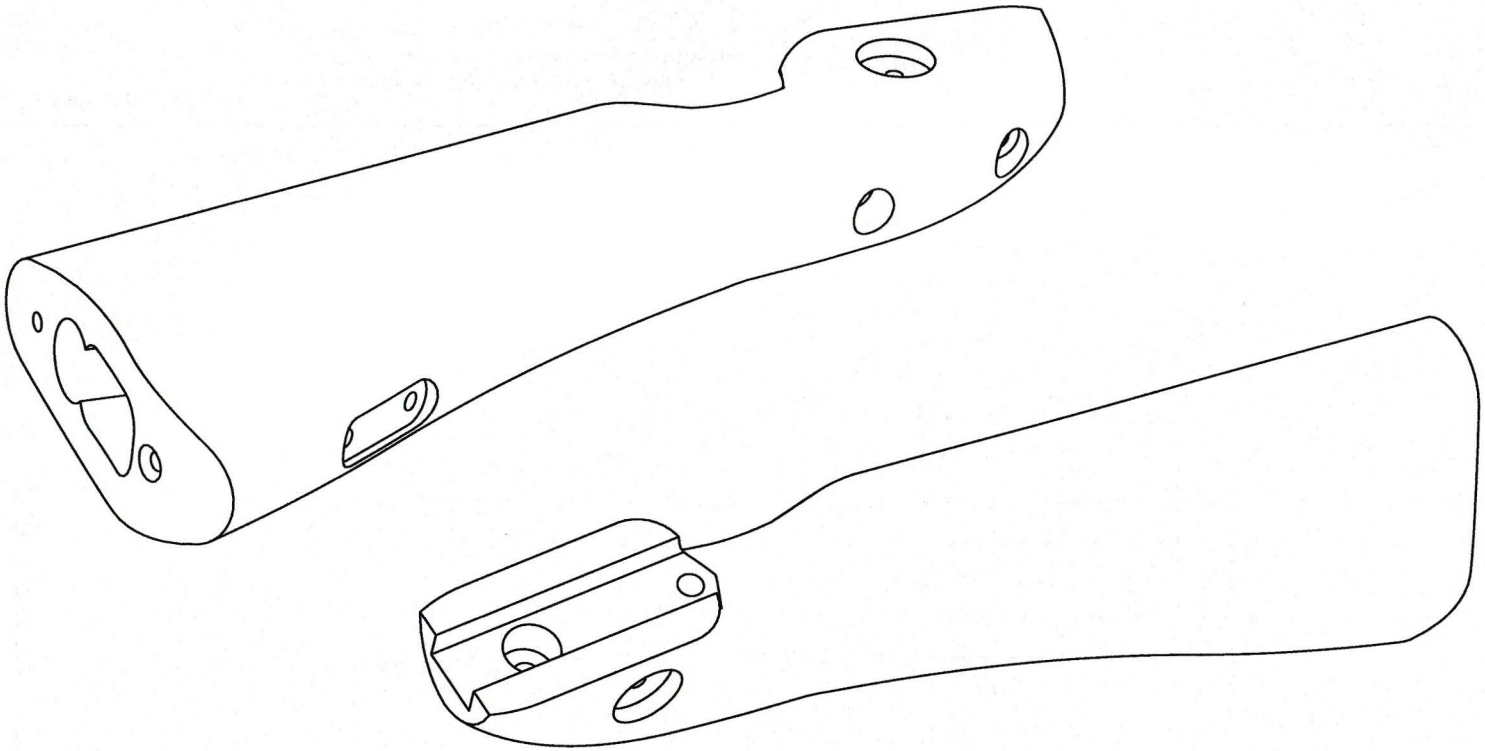
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ← .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ← C .XXX

Proprietary and Confidential

MATERIAL: Walnut	M1A1 Thompson
HEAT TREAT	PART NAME: Stock
HARDNESS	OPERATION NAME: Reinforcement Hole
FINISH	OPERATION NO.: 90 — SCALE: 1:2



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX) Proprietary and Confidential	MATERIAL: Walnut HEAT TREAT: HARDNESS: FINISH:	M1A1 Thompson PART NAME: Stock OPERATION NAME: Frame Interface OPERATION NO.: 100 SCALE: 1:2



Dimensions are in Inches

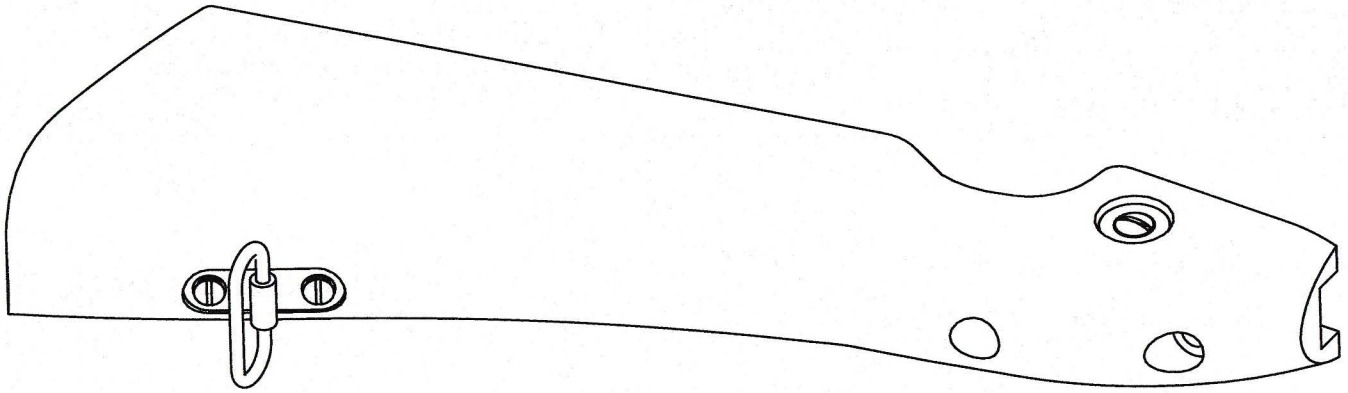
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX

2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX

Proprietary and Confidential

MATERIAL: Walnut	M1A1 Thompson
HEAT TREAT	PART NAME: Stock
HARDNESS	OPERATION NAME: Finish
FINISH: Stain and Oiled	OPERATION NO.: 110
	SCALE: 1:2



ITEM NO.	PART NUMBER	QTY.
1	Stock	1
2	Stock Reinforcement Washer Right	1
3	Stock Reinforcement Screw	1
4	Stock Reinforcement Washer	1
5	Sling Swivel Base	1
6	Sling Swivel Ret. Screw	2
7	Sling Swivel Loop	1

Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX)
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)

Proprietary and Confidential

MATERIAL

HEAT TREAT

HARDNESS

FINISH

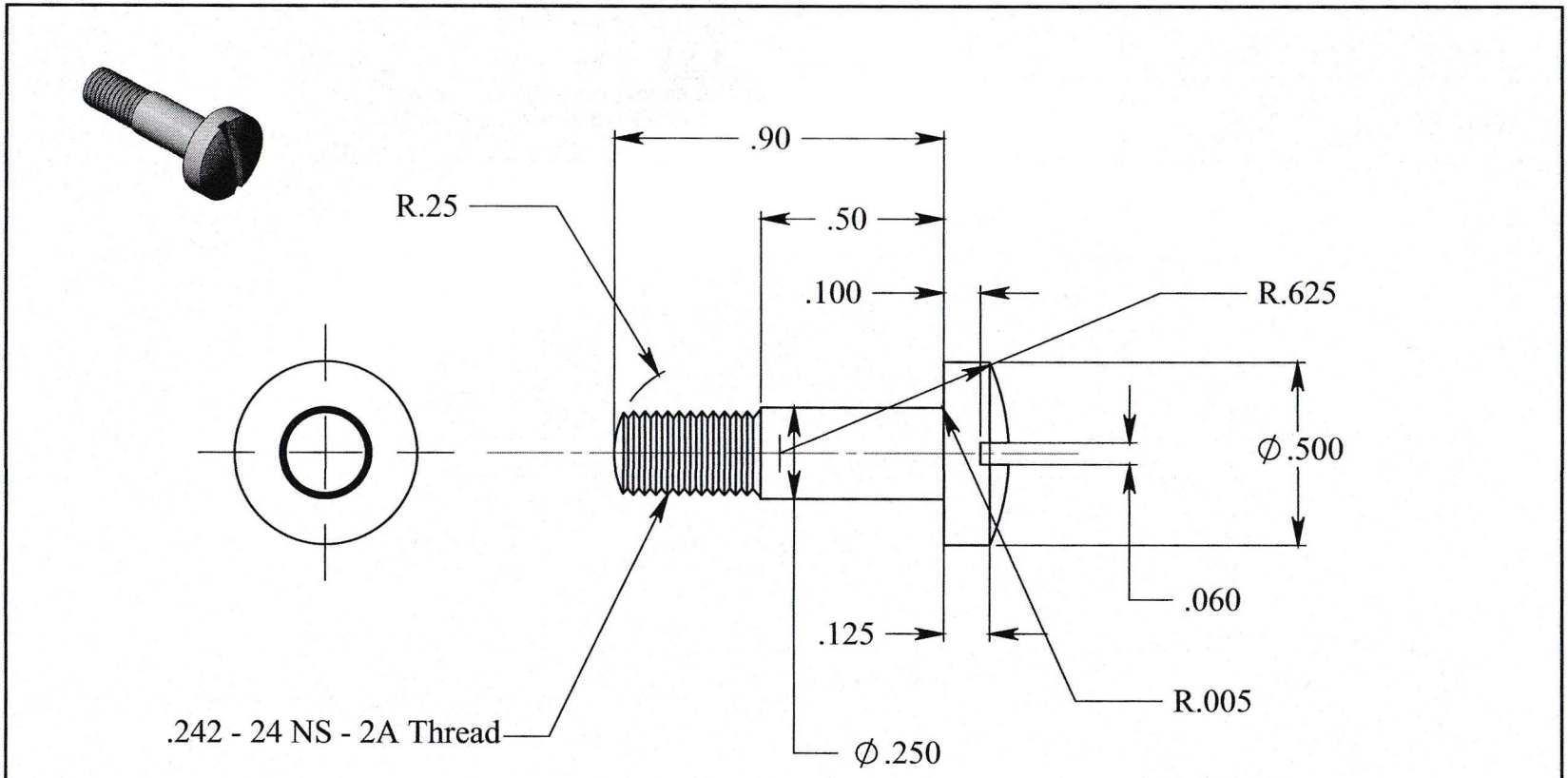
M1A1 Thompson

PART NAME: Stock Assembly

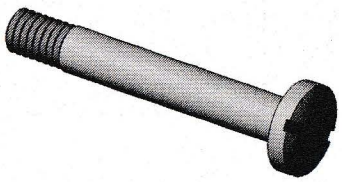
OPERATION NAME

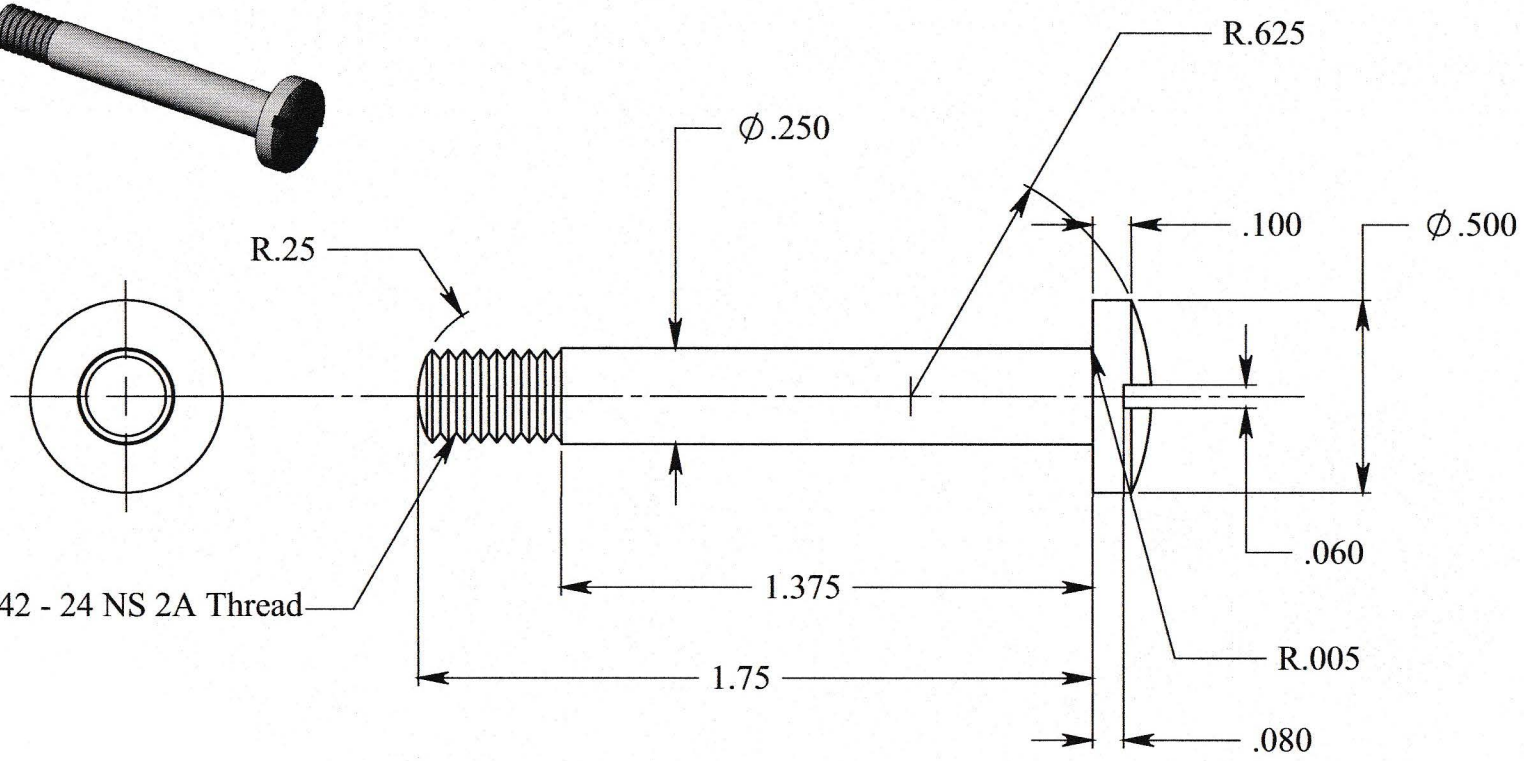
OPERATION NO.

SCALE: 1:2

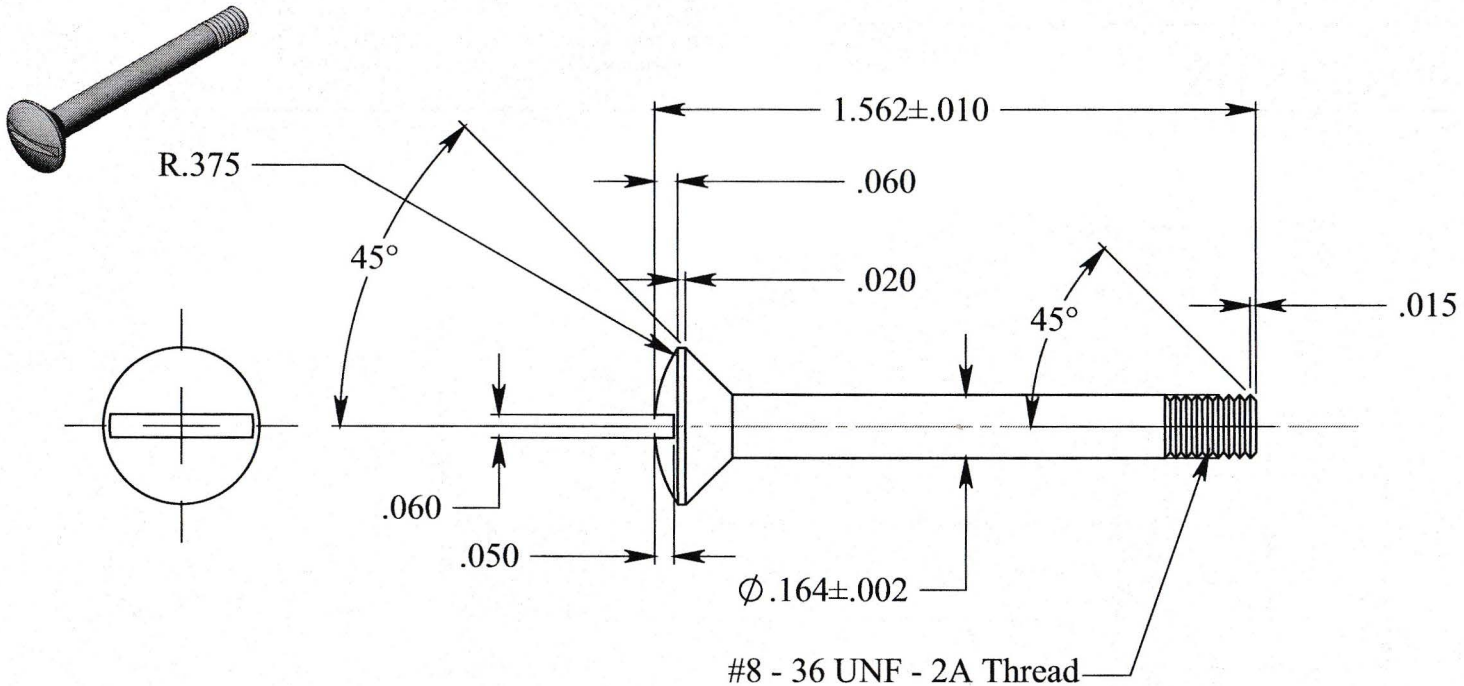


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX	MATERIAL AISI 4140	M1A1 Thompson
		HEAT TREAT Harden &Temper	PART NAME Front Takedown Screw
		HARDNESS HR15N 88 - 92	OPERATION NAME
		FINISH Black Oxide	OPERATION NO. / SCALE 2:1
	Proprietary and Confidential		





Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX) Proprietary and Confidential	MATERIAL AISI 4140 HEAT TREAT Harden &Temper HARDNESS HR15N 88 - 92 FINISH Black Oxide	M1A1 Thompson PART NAME Rear Takedown Screw OPERATION NAME OPERATION NO. SCALE 2:1



Dimensions are in Inches

Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

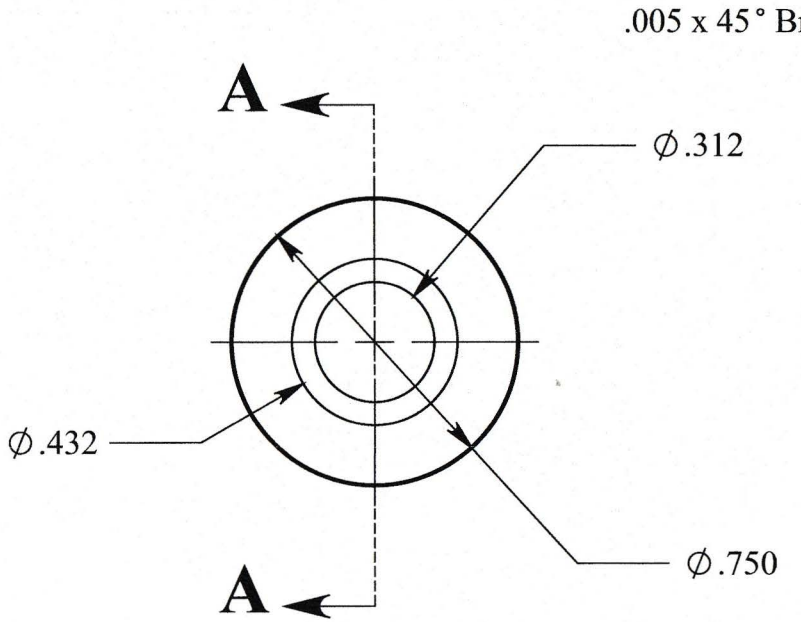
Notes:

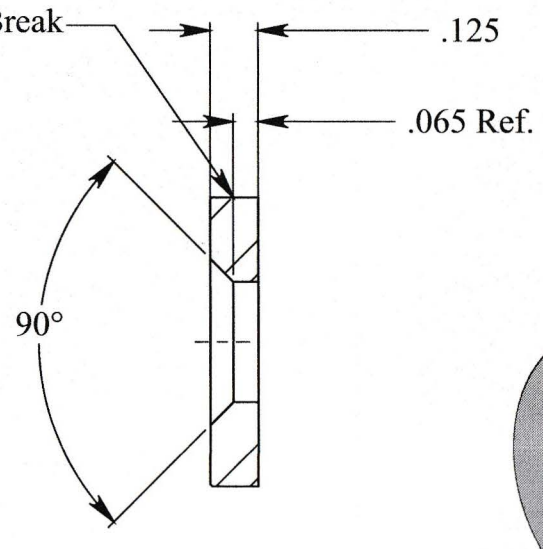
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX

2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

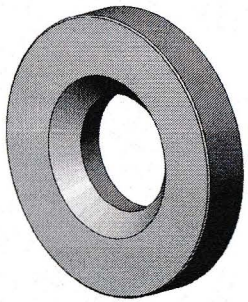
Proprietary and Confidential

MATERIAL: AISI 4140	M1A1 Thompson
HEAT TREAT: Harden &Temper	PART NAME: Stock Reinforcement Screw
HARDNESS: HR15N 88 - 92	OPERATION NAME:
FINISH: Black Oxide	OPERATION NO.: / SCALE: 2:1

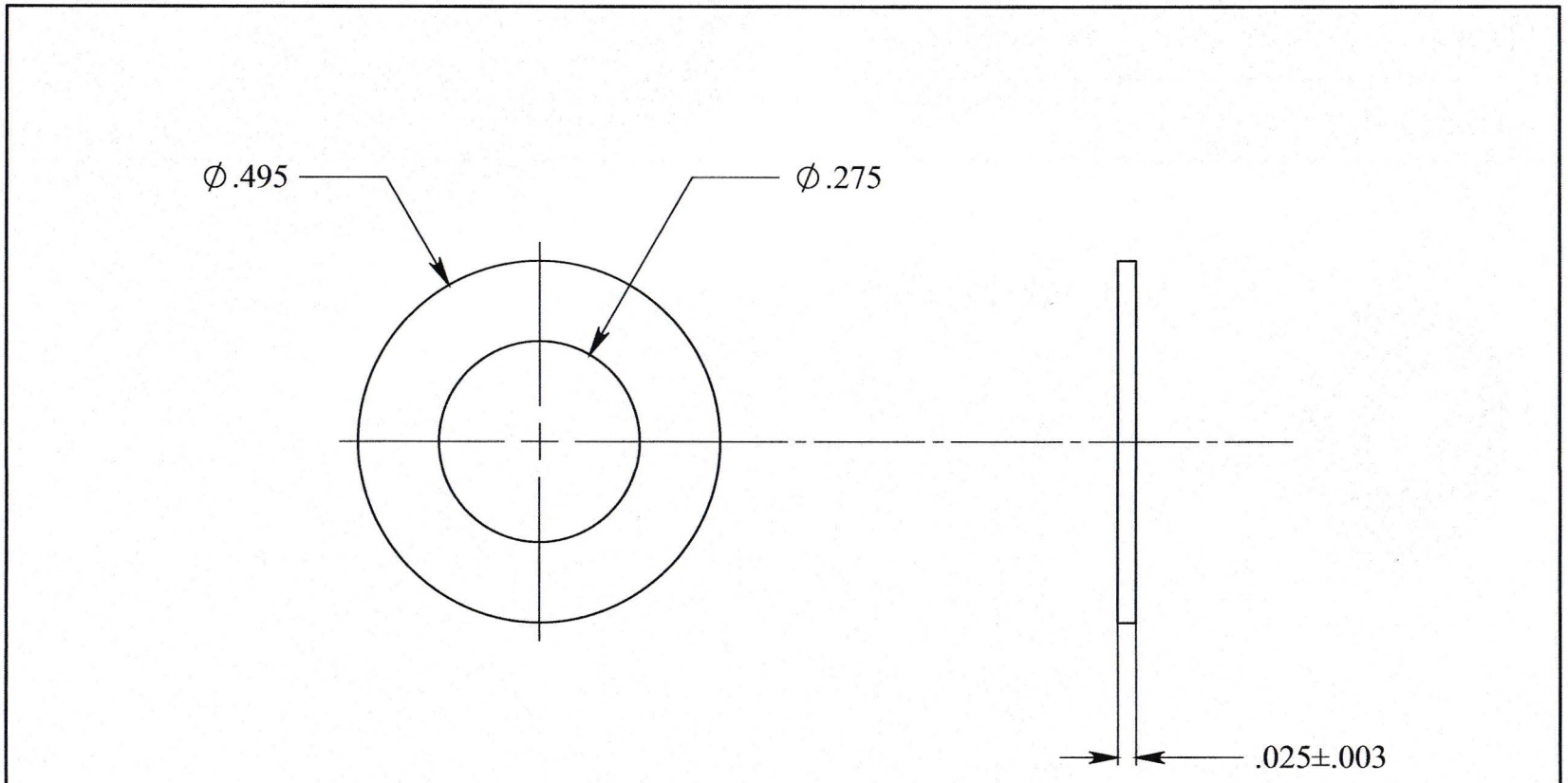




SECTION A-A



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL AISI 1118 HEAT TREAT Carburize .01 Case HARDNESS HR15N 88 - 92 FINISH Black Oxide	M1A1 Thompson PART NAME Stock Reinf. Washer Right OPERATION NAME OPERATION NO. SCALE 2:1



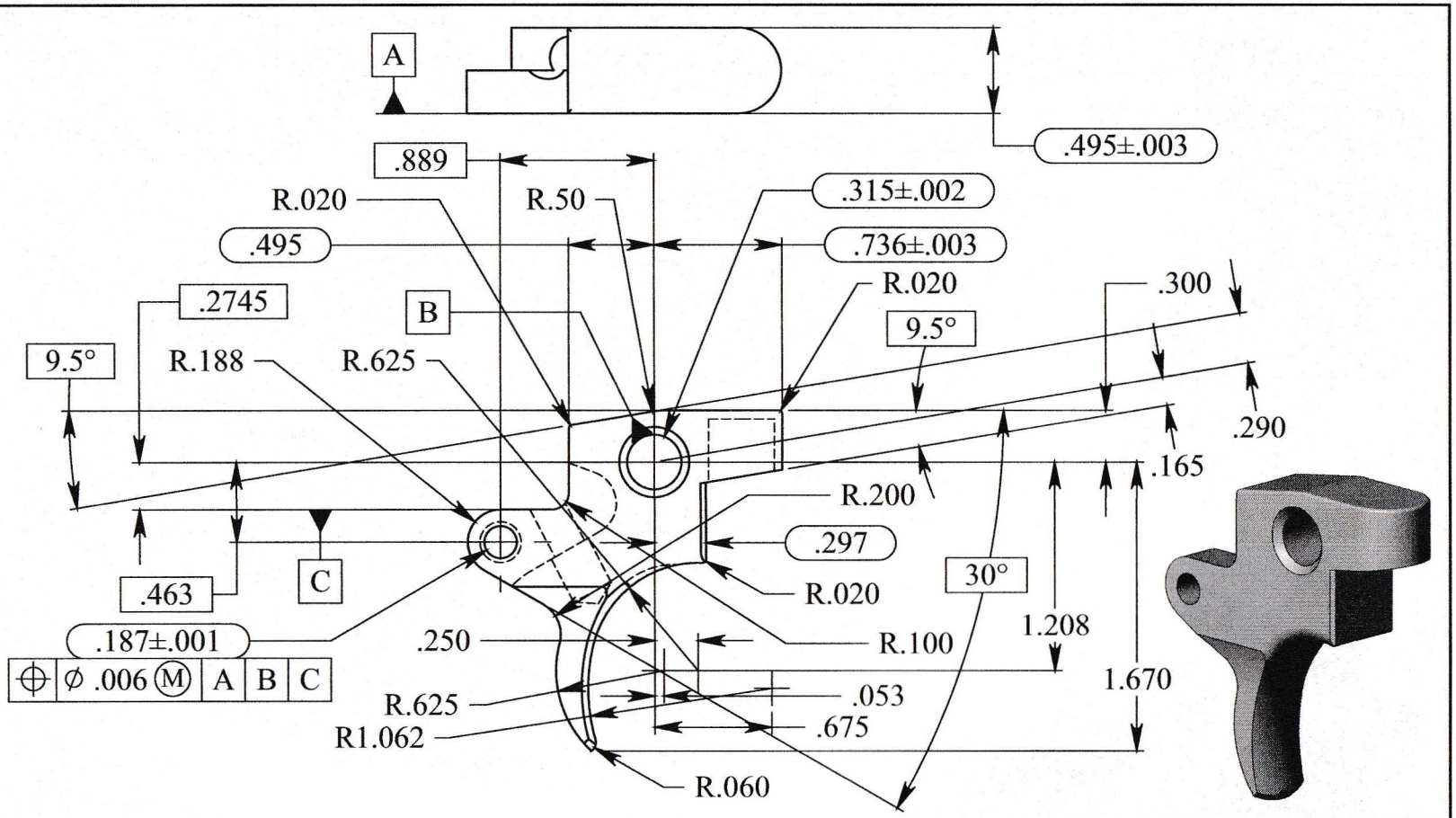
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

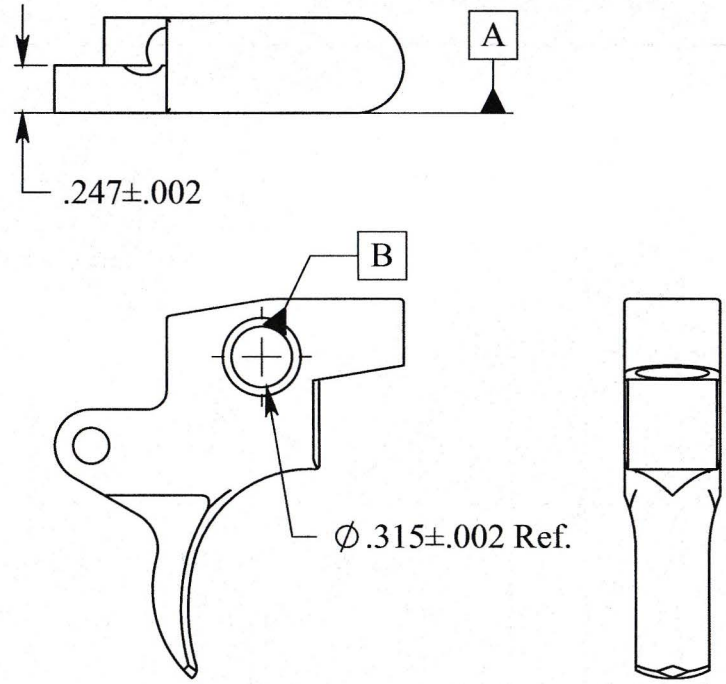
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

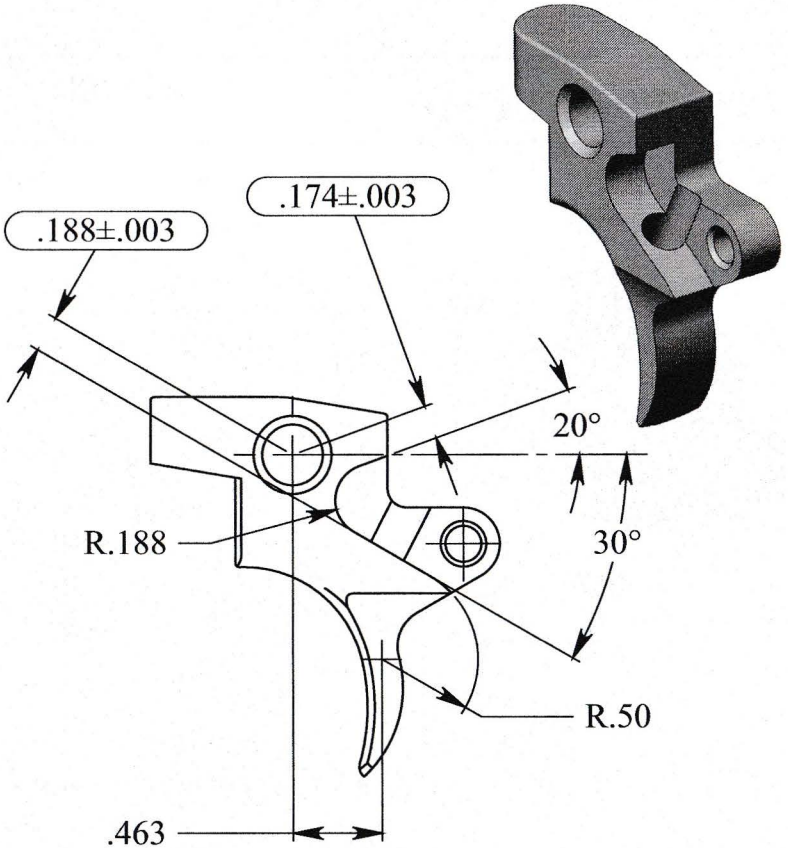
Proprietary and Confidential

MATERIAL: AISI 1118	M1A1 Thompson
HEAT TREAT: Carburize .70C	PART NAME: Stock Takedown Washer
HARDNESS: HR15N 88 - 92	OPERATION NAME:
FINISH: Black Oxide	OPERATION NO.: / SCALE: 2:1



Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL: AISI 1118 HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Trigger OPERATION NAME: Side Profile OPERATION NO.: 10 SCALE: 1:1





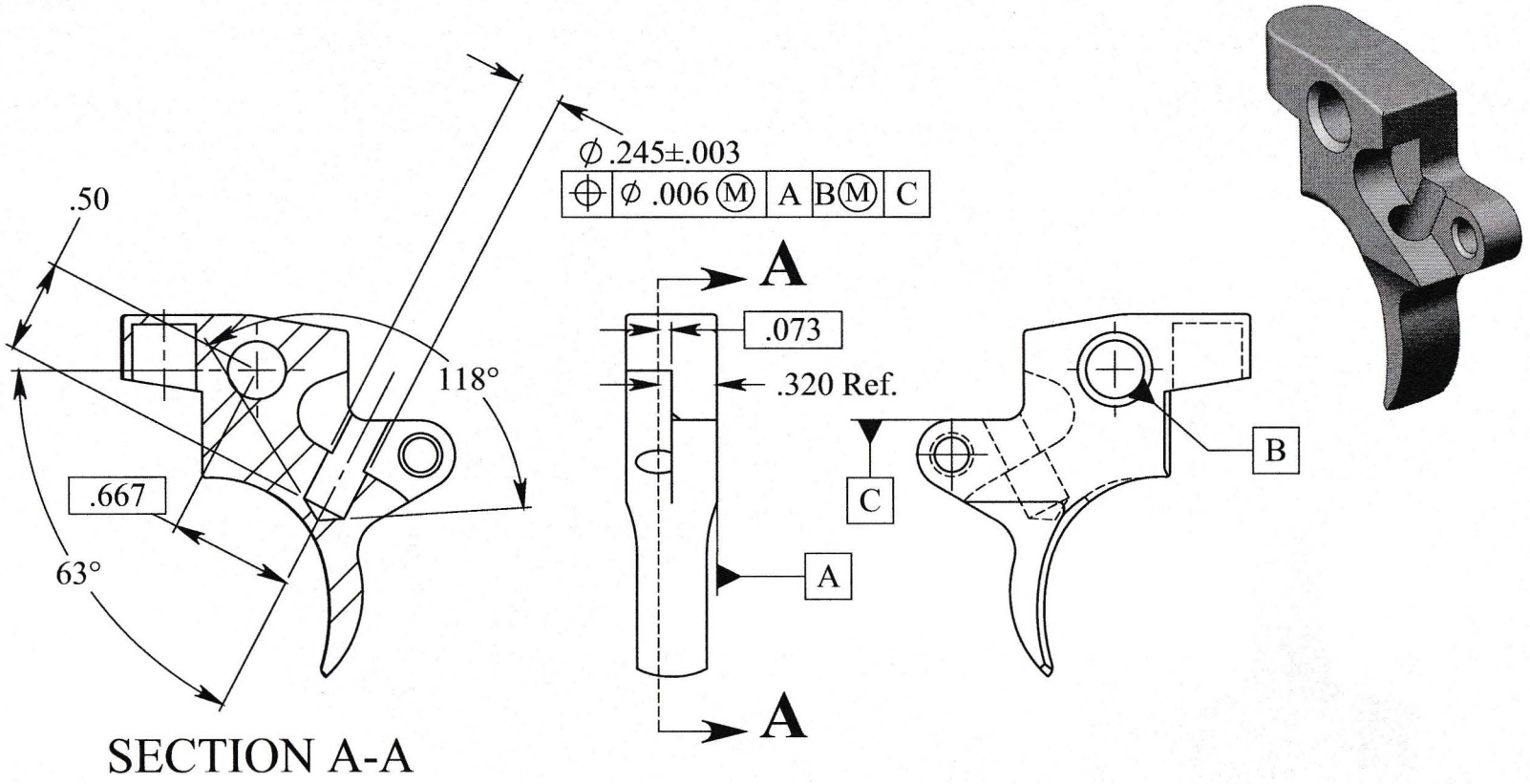
Dimensions are in Inches

Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

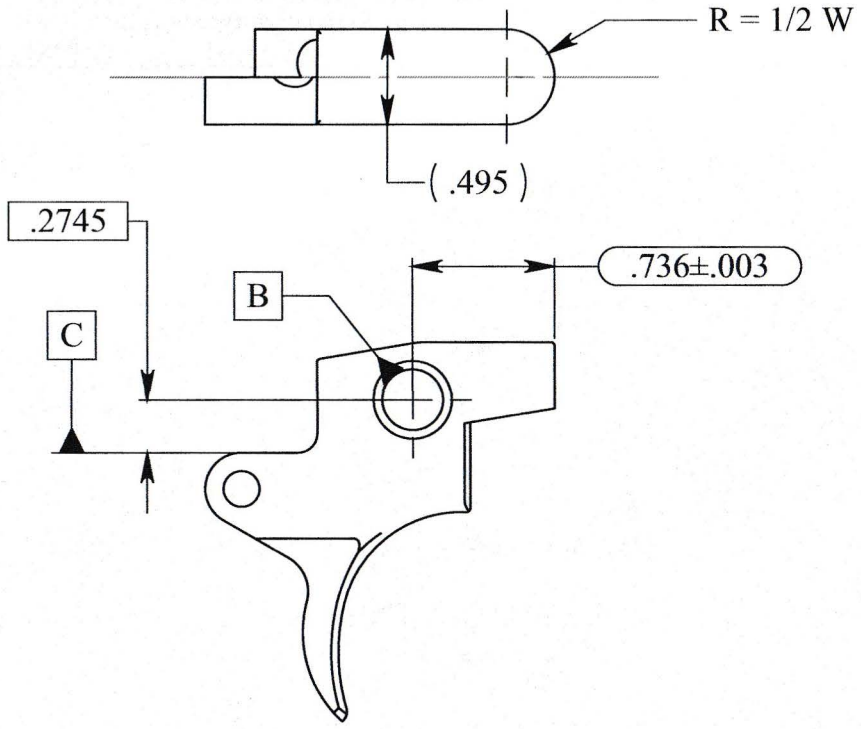
Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

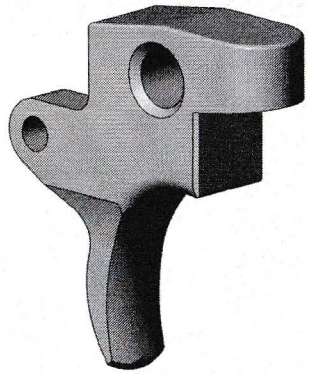
Proprietary and Confidential

MATERIAL: AISI 1118	M1A1 Thompson
HEAT TREAT	PART NAME: Trigger
HARDNESS	OPERATION NAME: Disc. Clearance
FINISH	OPERATION NO.: 20
	SCALE: 1:1

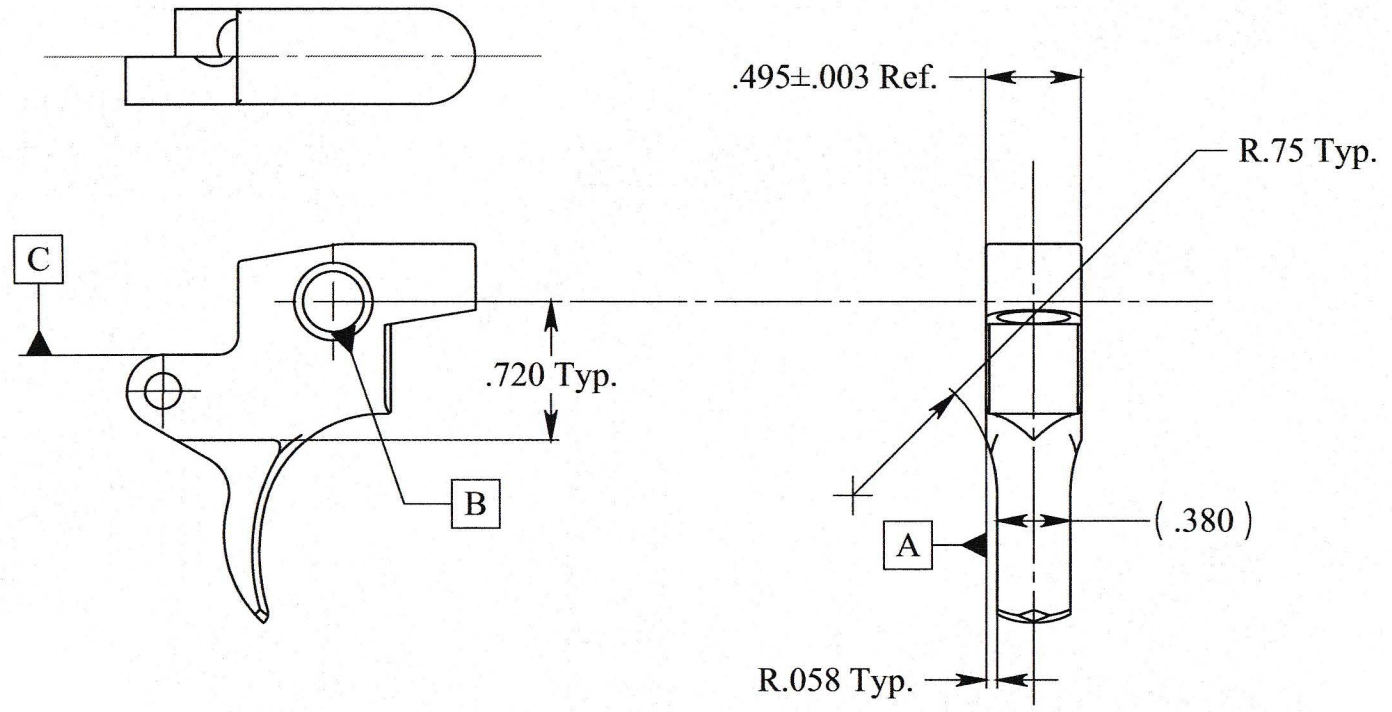


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL AISI 1118	M1A1 Thompson	
		HEAT TREAT	PART NAME Trigger	
		HARDNESS	OPERATION NAME Disc. Spring Hole	
		FINISH	OPERATION NO. 30	SCALE 1:1

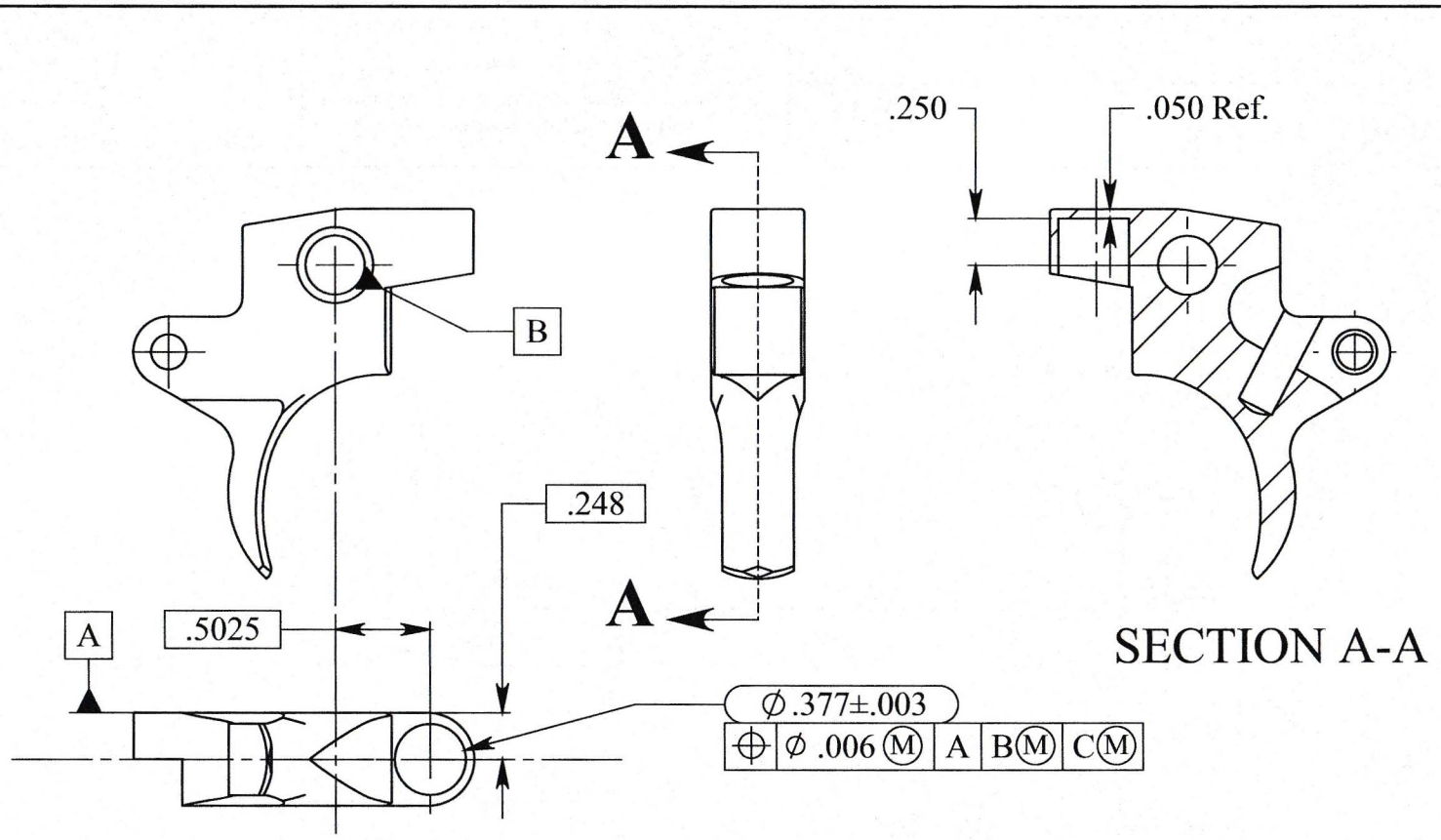




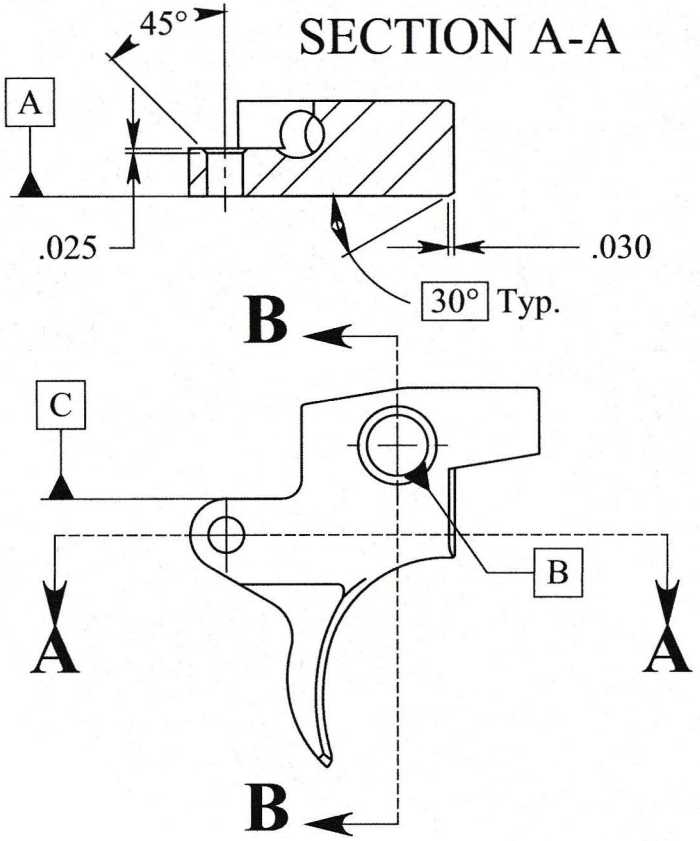
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 1118	M1A1 Thompson
		HEAT TREAT	PART NAME Trigger
		HARDNESS	OPERATION NAME Front Radius
	Proprietary and Confidential	FINISH	OPERATION NO. 40 — SCALE 1:1

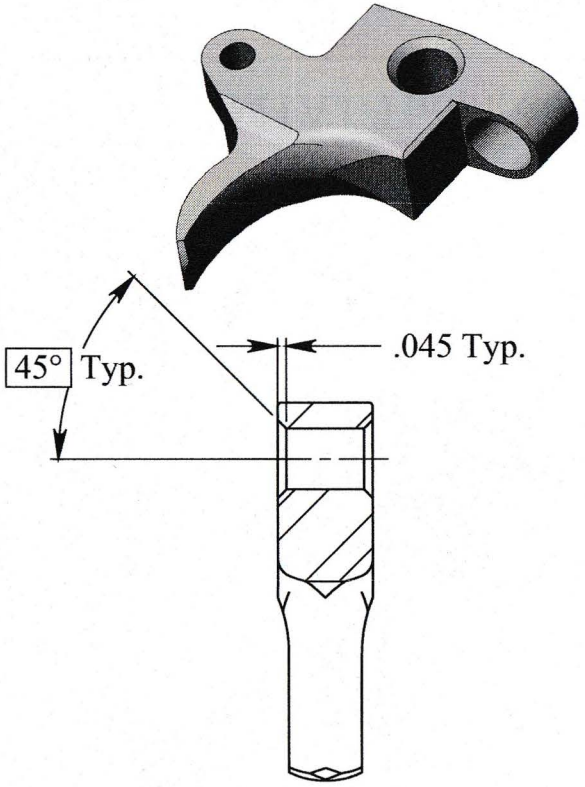


Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←(.XXX) 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←(C .XXX)	MATERIAL: AISI 1118 HEAT TREAT: HARDNESS: FINISH:	M1A1 Thompson PART NAME: Trigger OPERATION NAME: Bottom Profile OPERATION NO.: 50 SCALE: 1:1
	Proprietary and Confidential		



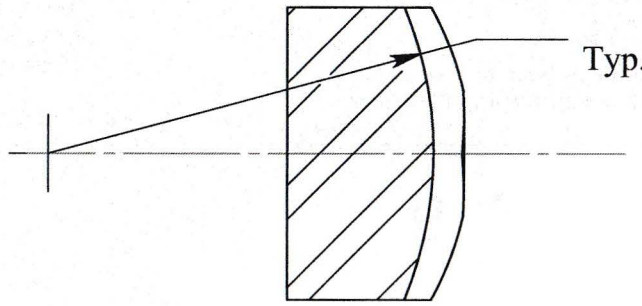
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL AISI 1118 HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME Trigger OPERATION NAME Trigger Spring Hole OPERATION NO. 60 SCALE 1:1



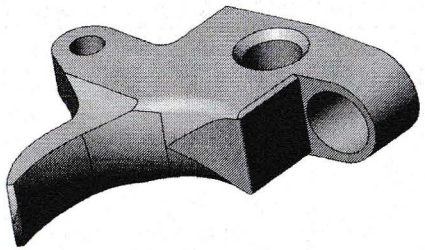


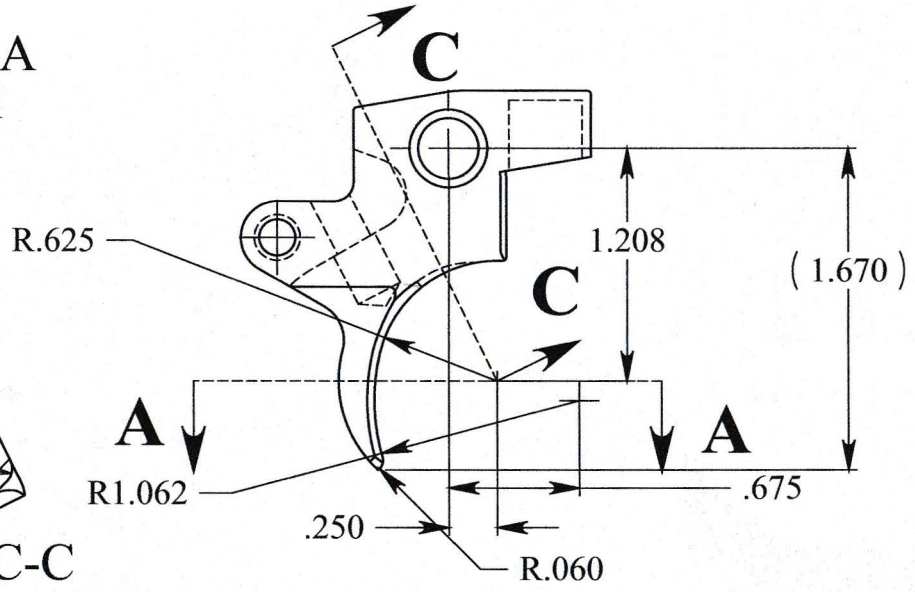
SECTION B-B

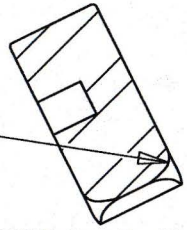
Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL AISI 1118 HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME Trigger OPERATION NAME Chamfers OPERATION NO. 70 SCALE 1:1



SECTION A-A
SCALE 4 : 1

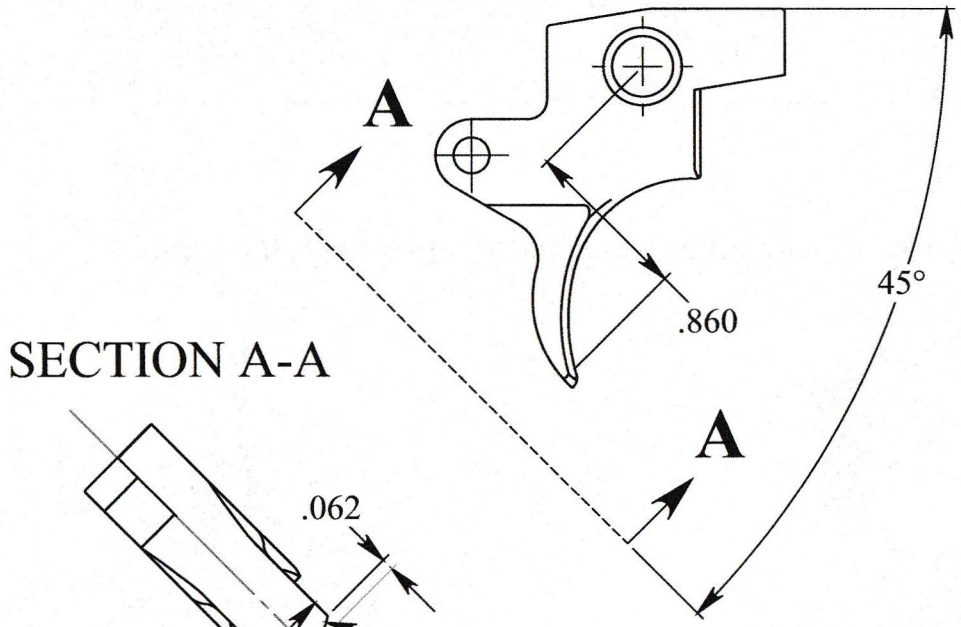




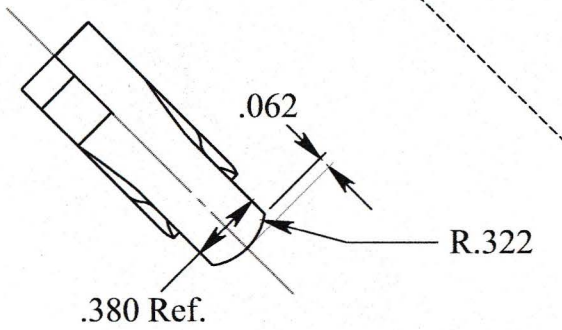


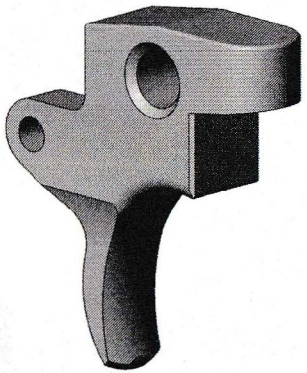
SECTION C-C

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX	MATERIAL AISI 1118	M1A1 Thompson
		HEAT TREAT	PART NAME Trigger
		HARDNESS	OPERATION NAME Bow Radius
	Proprietary and Confidential	FINISH	OPERATION NO. 80 / SCALE 1:1

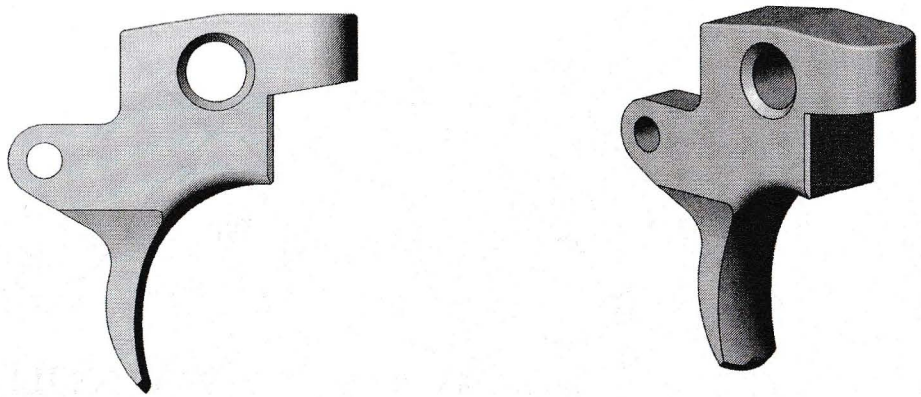


SECTION A-A





Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX Proprietary and Confidential	MATERIAL: AISI 1118 HEAT TREAT HARDNESS FINISH	M1A1 Thompson PART NAME: Trigger OPERATION NAME: Trigger Shoe Radius OPERATION NO.: 90 SCALE: 1:1



Media Tumble to Remove Burrs and Sharp Corners

Dimensions are in Inches Tolerances: Fractional = ± .015 Angular = ± .5° Two place decimal = ± .010 Three place dec. = ± .005	Notes: 1. Dimension shown with this symbol are important and must be inspected for part conformance → ←.XXX 2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → ←C .XXX	MATERIAL AISI 1118	M1A1 Thompson
		HEAT TREAT None	PART NAME Trigger
		HARDNESS HRB 100 Min.	OPERATION NAME Finishing
		FINISH Black Oxide	OPERATION NO. 100 / SCALE 1:1
	Proprietary and Confidential		

Manufaturing Data:

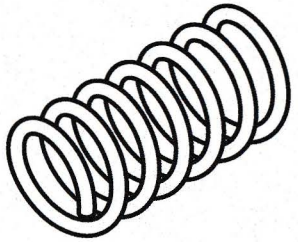
Spring Type:	Helical Compression
Outside Diameter:	.350 inches
Wire Diameter:	.041
Total Coils:	6.5
Active Coils:	6.5
Coil Type:	Open, Not Ground
Free Length:	.820
Wind Direction:	Either Hand

Inspection Data:

Load Length L1:	.420 inches
Load P1:	8.5 +/-1.1 lbs
Load Length L2:	.340
Load P2:	10.2 +/-1.2 lbs
Max. Solid Height:	.315 inches
Spring works in a:	.372 diameter hole
Spring works over:	.000 diameter rod

Engineering Data:

Spring Rate:	21.2 lbs/in.
Spring Index:	7.5
Static Solid Stress:	148,250 psi
Stress Percentage: at Solid Height	47%



Expand the last end coil on one end to an outside diameter of .395 +/-.005

Dimensions are in Inches

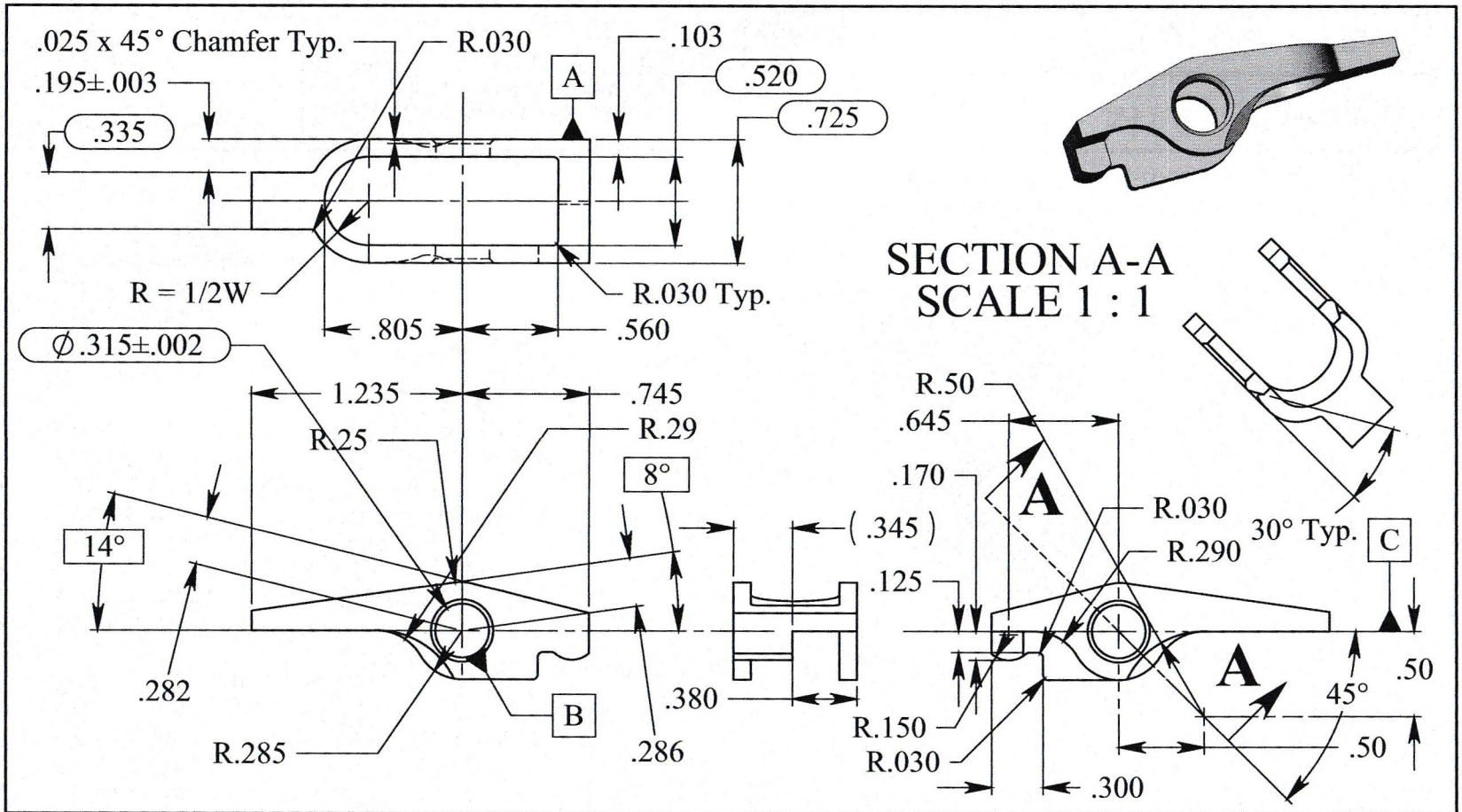
Tolerances:

Fractional	= ± .015
Angular	= ± .5°
Two place decimal	= ± .010
Three place dec.	= ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: Music Wire ASTM A228	M1A1 Thompson	
HEAT TREAT: Stress Relieve	PART NAME: Trigger Return Spring	
HARDNESS	OPERATION NAME	
FINISH	OPERATION NO.	SCALE: 2:1



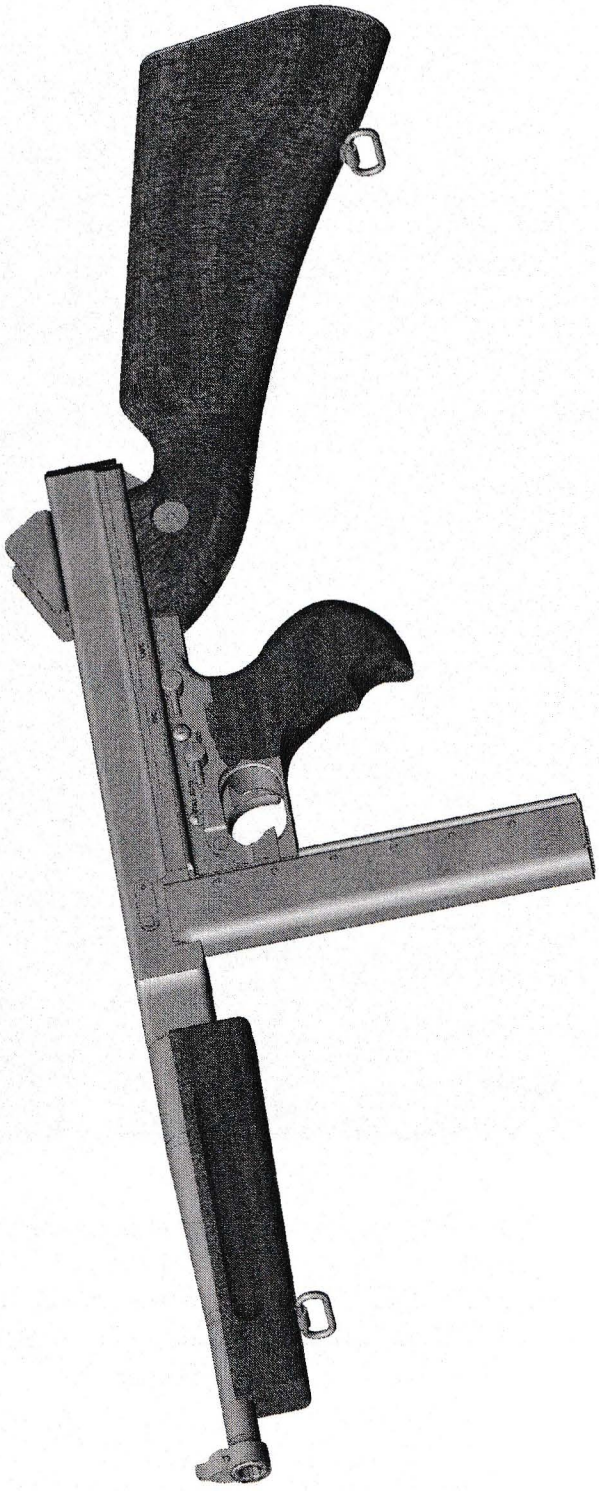
Dimensions are in Inches

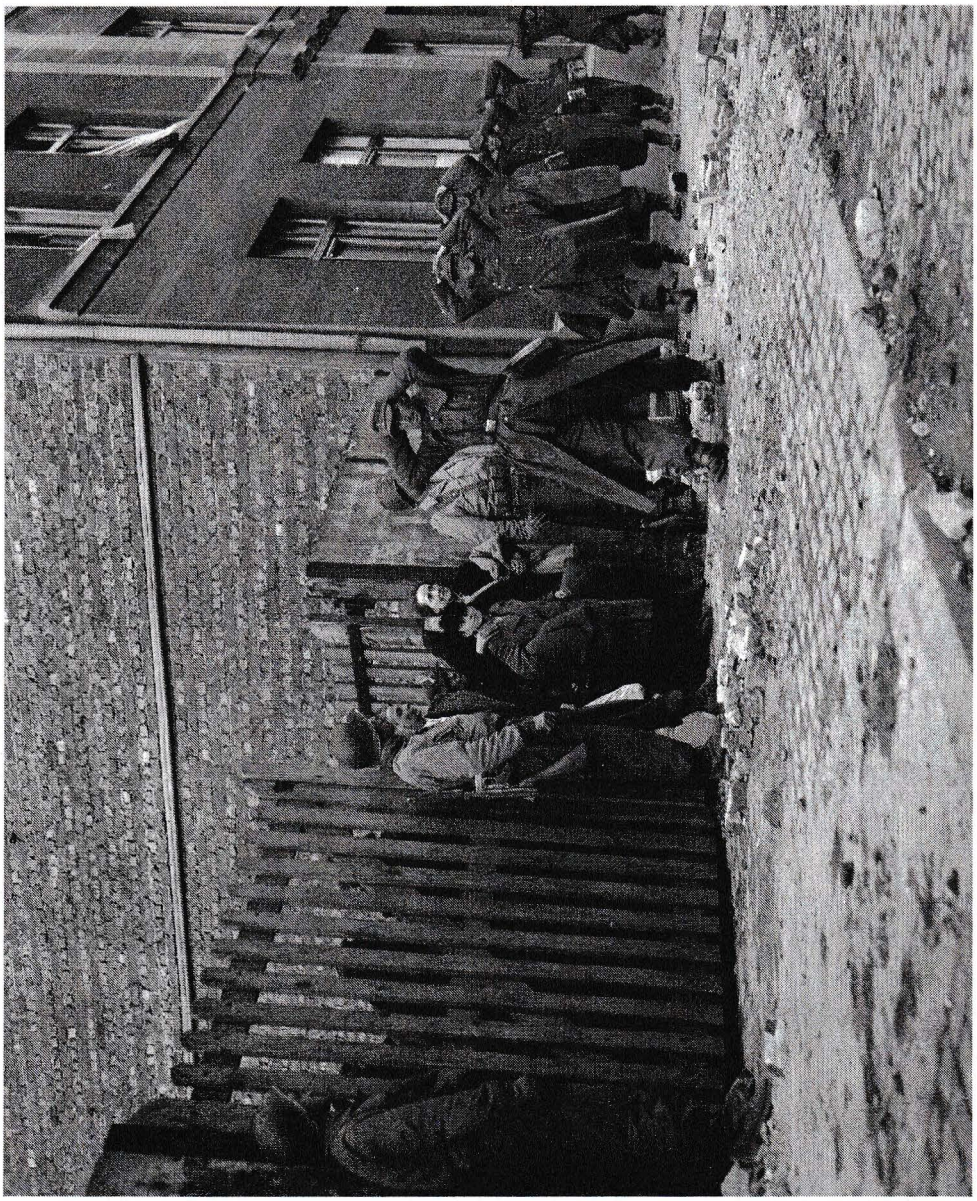
Tolerances:
Fractional = ± .015
Angular = ± .5°
Two place decimal = ± .010
Three place dec. = ± .005

Notes:
1. Dimension shown with this symbol are important and must be inspected for part conformance → .XXX
2. Dimensions with this symbol are critical to firearm function and must be inspected 100% → C .XXX

Proprietary and Confidential

MATERIAL: AISI 1118	M1A1 Thompson
HEAT TREAT: Carburize .010 Case	PART NAME: Trip
HARDNESS: HR15N 76 - 80	OPERATION NAME:
FINISH: Black Oxide	OPERATION NO.: / SCALE: 1:1





From the National Archives and Record Administration
111-SC-195460
German soldiers are marched through the streets of Aachen
under the gaze of German civilians and watched by a soldier with his
M1A1 Thompson.

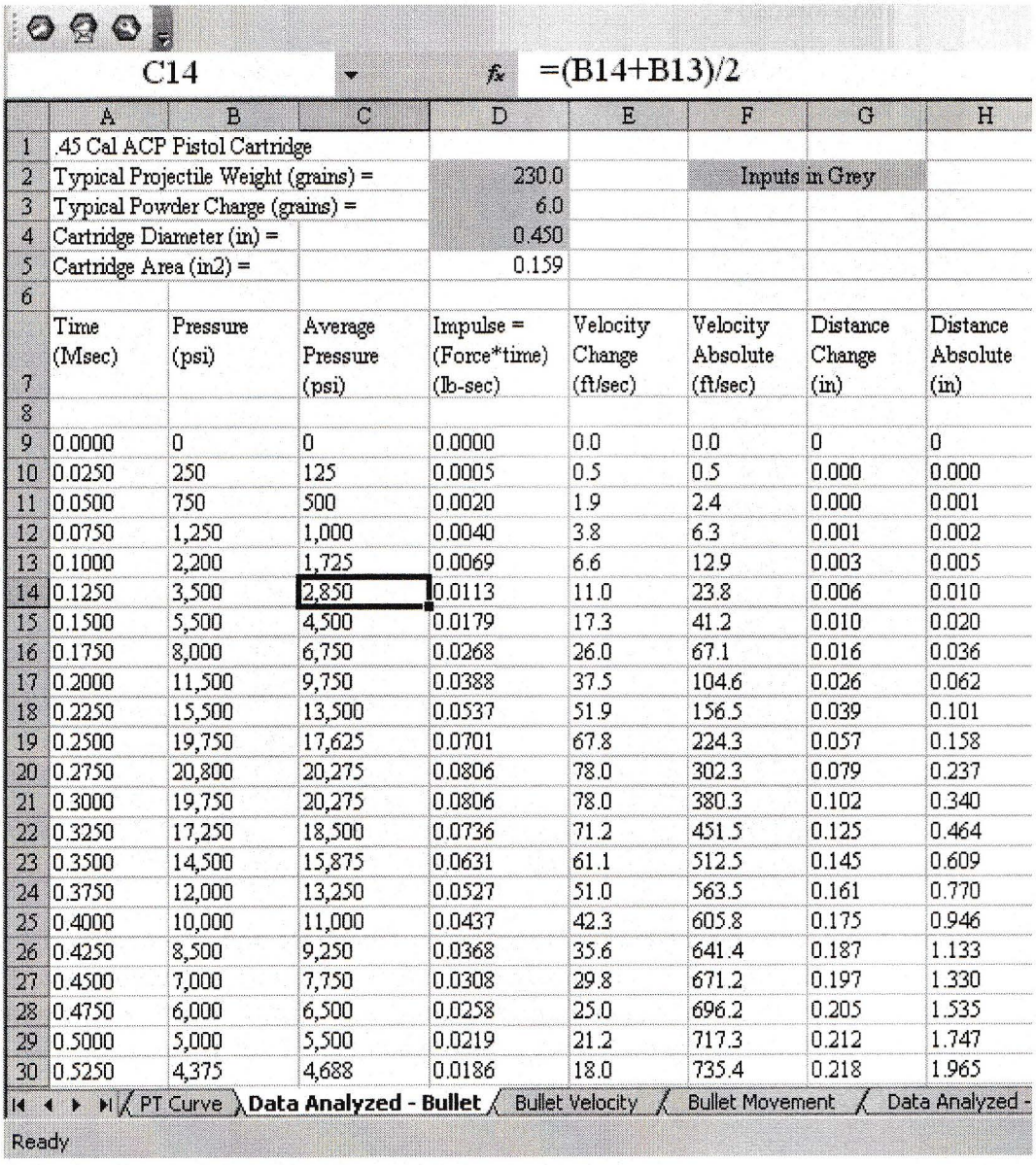
Appendix I

Patent History of the Thompson Submachine Gun[1]

Patent No.	Inventor	Description	Date Issued
1,131,319	J. Blish	Breech Closure for Firearms	Mar. 9, 1915
1,338,866	O.V. Payne	Firearm	May 4, 1920
1,340,891	O.B. Graham	Breech Closure	May 25, 1920
1,340,943	T.H. Eickhoff and O.V. Payne	Breech Closure	May 25, 1920
1,347,754	O.V. Payne	Firearm	July 27, 1920
1,349,345	O.V. Payne	Firearm	Aug. 10, 1920
1,349,350	C.A. Tunks	Magazine	Aug. 10, 1920
1,357,208	O.V. Payne	Firearm	Oct. 26, 1920
1,361,402	O.V. Payne	Magazine for Firearms	Dec. 7, 1920
1,352,414	O.V. Payne	Breech Lubrication	Sept. 7, 1920
1,363,809	O.V. Payne	Firearm	Dec 28, 1920
1,399,440	O.V. Payne	Gun	Dec 6, 1921
1,403,492	T.H. Eickhoff	Hammer Construction	Jan. 17, 1922
1,403,623	O.V. Payne	Gun	Jan. 17, 1922
1,406,546	T.H. Eickhoff	Breech Closure for Firearms	Feb. 14, 1922
1,408,276	T.H. Eickhoff	Gun Sight	Feb. 28, 1922
1,475,761	G.O. Fisher	Automatic Gun	Nov. 27, 1923
1,636,357	R.M. Cutts, Jr.	Anti-Climb Device	July 19, 1927
1,817,321	O.V. Payne	Firearm	Aug. 4, 1931
2,427,304	C.W. Robbins	Automatic Sear Release for Firearms	Sept. 9, 1947

Appendix II
Excel Screen Shots for Determining Cartridge Impulse

The following screen shots will assist you set up your own Excel spreadsheet for determining the impulse of a cartridge given its pressure versus time curve as in Chapter II.

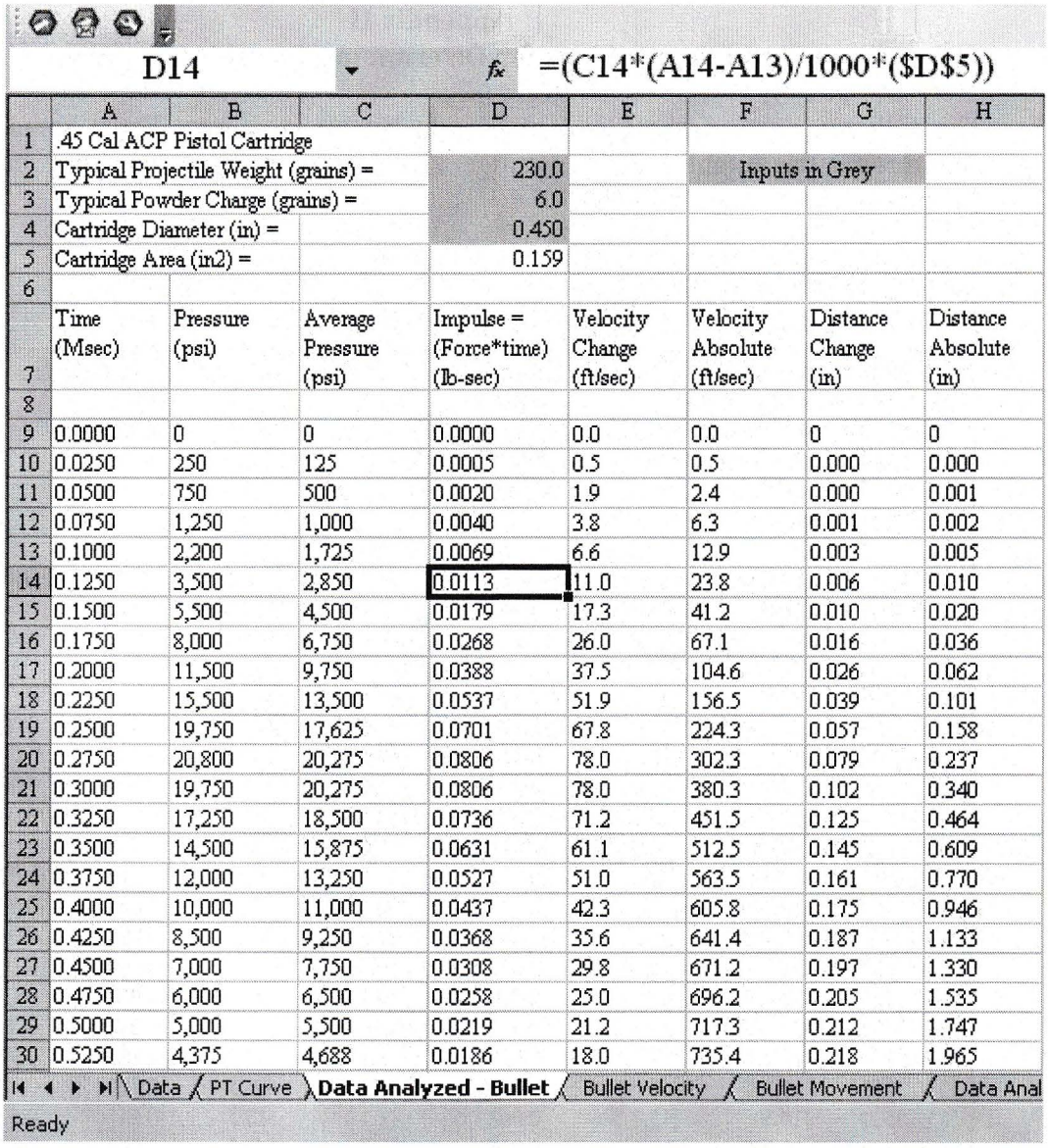


C14 =(B14+B13)/2

	A	B	C	D	E	F	G	H
1	.45 Cal ACP Pistol Cartridge							
2	Typical Projectile Weight (grains) =			230.0		Inputs in Grey		
3	Typical Powder Charge (grains) =			6.0				
4	Cartridge Diameter (in) =			0.450				
5	Cartridge Area (in2) =			0.159				
6								
7	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Velocity Change (ft/sec)	Velocity Absolute (ft/sec)	Distance Change (in)	Distance Absolute (in)
8								
9	0.0000	0	0	0.0000	0.0	0.0	0	0
10	0.0250	250	125	0.0005	0.5	0.5	0.000	0.000
11	0.0500	750	500	0.0020	1.9	2.4	0.000	0.001
12	0.0750	1,250	1,000	0.0040	3.8	6.3	0.001	0.002
13	0.1000	2,200	1,725	0.0069	6.6	12.9	0.003	0.005
14	0.1250	3,500	2,850	0.0113	11.0	23.8	0.006	0.010
15	0.1500	5,500	4,500	0.0179	17.3	41.2	0.010	0.020
16	0.1750	8,000	6,750	0.0268	26.0	67.1	0.016	0.036
17	0.2000	11,500	9,750	0.0388	37.5	104.6	0.026	0.062
18	0.2250	15,500	13,500	0.0537	51.9	156.5	0.039	0.101
19	0.2500	19,750	17,625	0.0701	67.8	224.3	0.057	0.158
20	0.2750	20,800	20,275	0.0806	78.0	302.3	0.079	0.237
21	0.3000	19,750	20,275	0.0806	78.0	380.3	0.102	0.340
22	0.3250	17,250	18,500	0.0736	71.2	451.5	0.125	0.464
23	0.3500	14,500	15,875	0.0631	61.1	512.5	0.145	0.609
24	0.3750	12,000	13,250	0.0527	51.0	563.5	0.161	0.770
25	0.4000	10,000	11,000	0.0437	42.3	605.8	0.175	0.946
26	0.4250	8,500	9,250	0.0368	35.6	641.4	0.187	1.133
27	0.4500	7,000	7,750	0.0308	29.8	671.2	0.197	1.330
28	0.4750	6,000	6,500	0.0258	25.0	696.2	0.205	1.535
29	0.5000	5,000	5,500	0.0219	21.2	717.3	0.212	1.747
30	0.5250	4,375	4,688	0.0186	18.0	735.4	0.218	1.965

PT Curve | Data Analyzed - Bullet | Bullet Velocity | Bullet Movement | Data Analyzed -

Ready



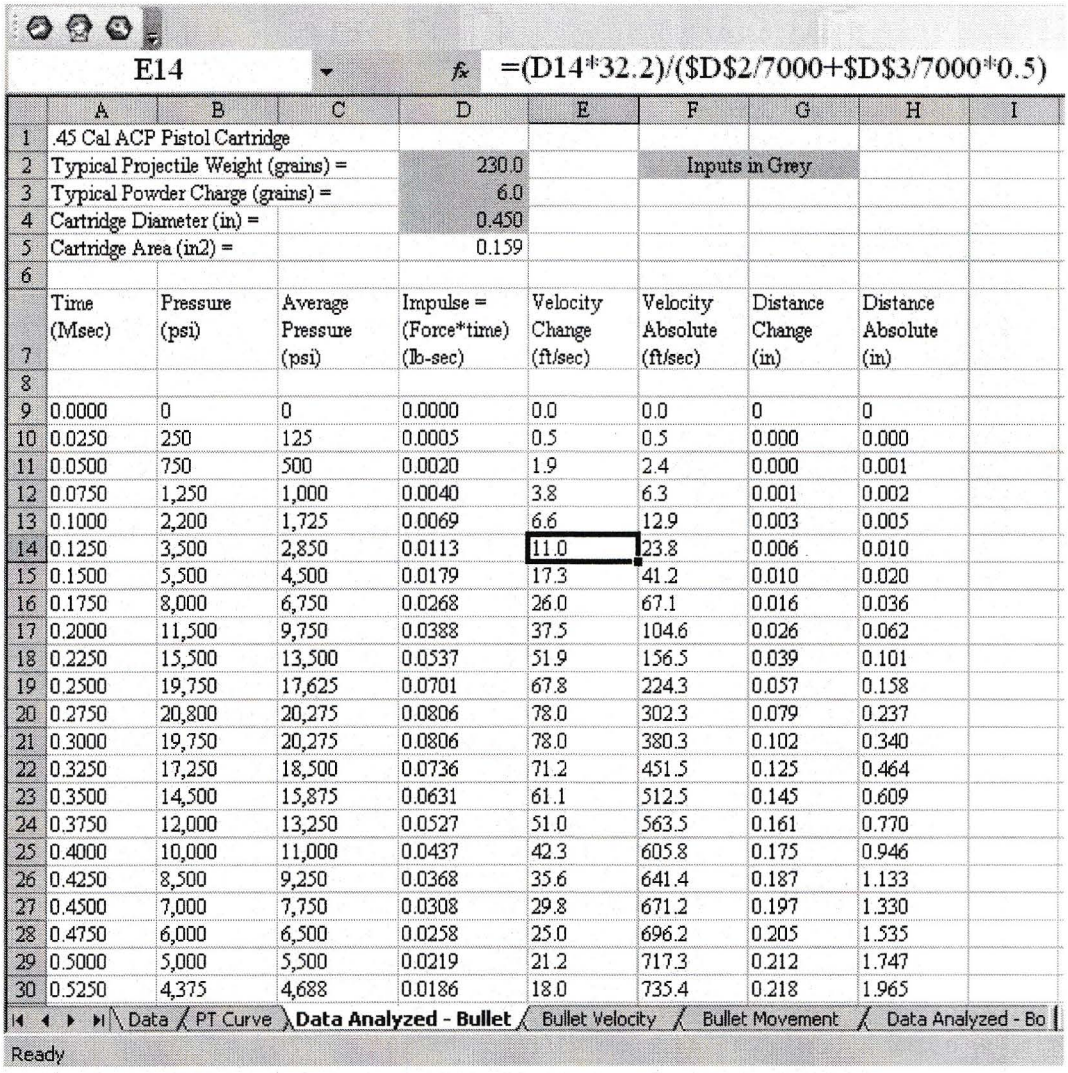
D14 fx =(C14*(A14-A13)/1000*($D$5))

	A	B	C	D	E	F	G	H
1	.45 Cal ACP Pistol Cartridge							
2	Typical Projectile Weight (grains) =			230.0		Inputs in Grey		
3	Typical Powder Charge (grains) =			6.0				
4	Cartridge Diameter (in) =			0.450				
5	Cartridge Area (in2) =			0.159				
6								
7	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Velocity Change (ft/sec)	Velocity Absolute (ft/sec)	Distance Change (in)	Distance Absolute (in)
8								
9	0.0000	0	0	0.0000	0.0	0.0	0	0
10	0.0250	250	125	0.0005	0.5	0.5	0.000	0.000
11	0.0500	750	500	0.0020	1.9	2.4	0.000	0.001
12	0.0750	1,250	1,000	0.0040	3.8	6.3	0.001	0.002
13	0.1000	2,200	1,725	0.0069	6.6	12.9	0.003	0.005
14	0.1250	3,500	2,850	0.0113	11.0	23.8	0.006	0.010
15	0.1500	5,500	4,500	0.0179	17.3	41.2	0.010	0.020
16	0.1750	8,000	6,750	0.0268	26.0	67.1	0.016	0.036
17	0.2000	11,500	9,750	0.0388	37.5	104.6	0.026	0.062
18	0.2250	15,500	13,500	0.0537	51.9	156.5	0.039	0.101
19	0.2500	19,750	17,625	0.0701	67.8	224.3	0.057	0.158
20	0.2750	20,800	20,275	0.0806	78.0	302.3	0.079	0.237
21	0.3000	19,750	20,275	0.0806	78.0	380.3	0.102	0.340
22	0.3250	17,250	18,500	0.0736	71.2	451.5	0.125	0.464
23	0.3500	14,500	15,875	0.0631	61.1	512.5	0.145	0.609
24	0.3750	12,000	13,250	0.0527	51.0	563.5	0.161	0.770
25	0.4000	10,000	11,000	0.0437	42.3	605.8	0.175	0.946
26	0.4250	8,500	9,250	0.0368	35.6	641.4	0.187	1.133
27	0.4500	7,000	7,750	0.0308	29.8	671.2	0.197	1.330
28	0.4750	6,000	6,500	0.0258	25.0	696.2	0.205	1.535
29	0.5000	5,000	5,500	0.0219	21.2	717.3	0.212	1.747
30	0.5250	4,375	4,688	0.0186	18.0	735.4	0.218	1.965

Data | PT Curve | **Data Analyzed - Bullet** | Bullet Velocity | Bullet Movement | Data Anal

Ready

Excel Note: Placing the cursor at the end of a variable and pressing the F4 key allows the operator to copy that variable down a column without it changing. In this case we wish to copy D5 in the column without changing. Excel inserts a "$" symbol before and after the letter of the box being copied when the F4 key is selected.

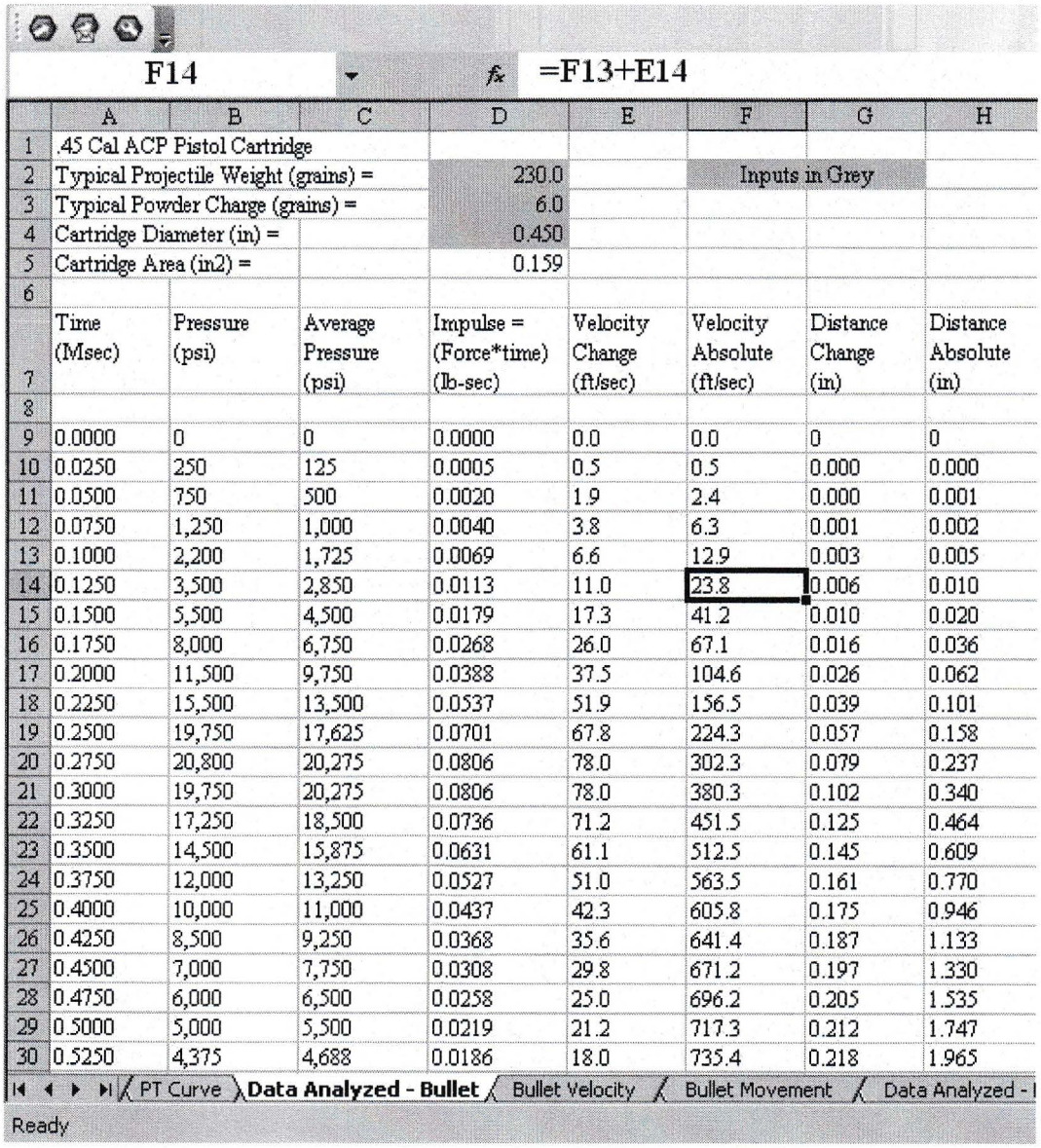


E14 fx =(D14*32.2)/($D$2/7000+$D$3/7000*0.5)

	A	B	C	D	E	F	G	H	I
1	.45 Cal ACP Pistol Cartridge								
2	Typical Projectile Weight (grains) =			230.0		Inputs in Grey			
3	Typical Powder Charge (grains) =			6.0					
4	Cartridge Diameter (in) =			0.450					
5	Cartridge Area (in2) =			0.159					
6									
7	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Velocity Change (ft/sec)	Velocity Absolute (ft/sec)	Distance Change (in)	Distance Absolute (in)	
8									
9	0.0000	0	0	0.0000	0.0	0.0	0	0	
10	0.0250	250	125	0.0005	0.5	0.5	0.000	0.000	
11	0.0500	750	500	0.0020	1.9	2.4	0.000	0.001	
12	0.0750	1,250	1,000	0.0040	3.8	6.3	0.001	0.002	
13	0.1000	2,200	1,725	0.0069	6.6	12.9	0.003	0.005	
14	0.1250	3,500	2,850	0.0113	11.0	23.8	0.006	0.010	
15	0.1500	5,500	4,500	0.0179	17.3	41.2	0.010	0.020	
16	0.1750	8,000	6,750	0.0268	26.0	67.1	0.016	0.036	
17	0.2000	11,500	9,750	0.0388	37.5	104.6	0.026	0.062	
18	0.2250	15,500	13,500	0.0537	51.9	156.5	0.039	0.101	
19	0.2500	19,750	17,625	0.0701	67.8	224.3	0.057	0.158	
20	0.2750	20,800	20,275	0.0806	78.0	302.3	0.079	0.237	
21	0.3000	19,750	20,275	0.0806	78.0	380.3	0.102	0.340	
22	0.3250	17,250	18,500	0.0736	71.2	451.5	0.125	0.464	
23	0.3500	14,500	15,875	0.0631	61.1	512.5	0.145	0.609	
24	0.3750	12,000	13,250	0.0527	51.0	563.5	0.161	0.770	
25	0.4000	10,000	11,000	0.0437	42.3	605.8	0.175	0.946	
26	0.4250	8,500	9,250	0.0368	35.6	641.4	0.187	1.133	
27	0.4500	7,000	7,750	0.0308	29.8	671.2	0.197	1.330	
28	0.4750	6,000	6,500	0.0258	25.0	696.2	0.205	1.535	
29	0.5000	5,000	5,500	0.0219	21.2	717.3	0.212	1.747	
30	0.5250	4,375	4,688	0.0186	18.0	735.4	0.218	1.965	

Data | PT Curve | **Data Analyzed - Bullet** | Bullet Velocity | Bullet Movement | Data Analyzed - Bo

Ready

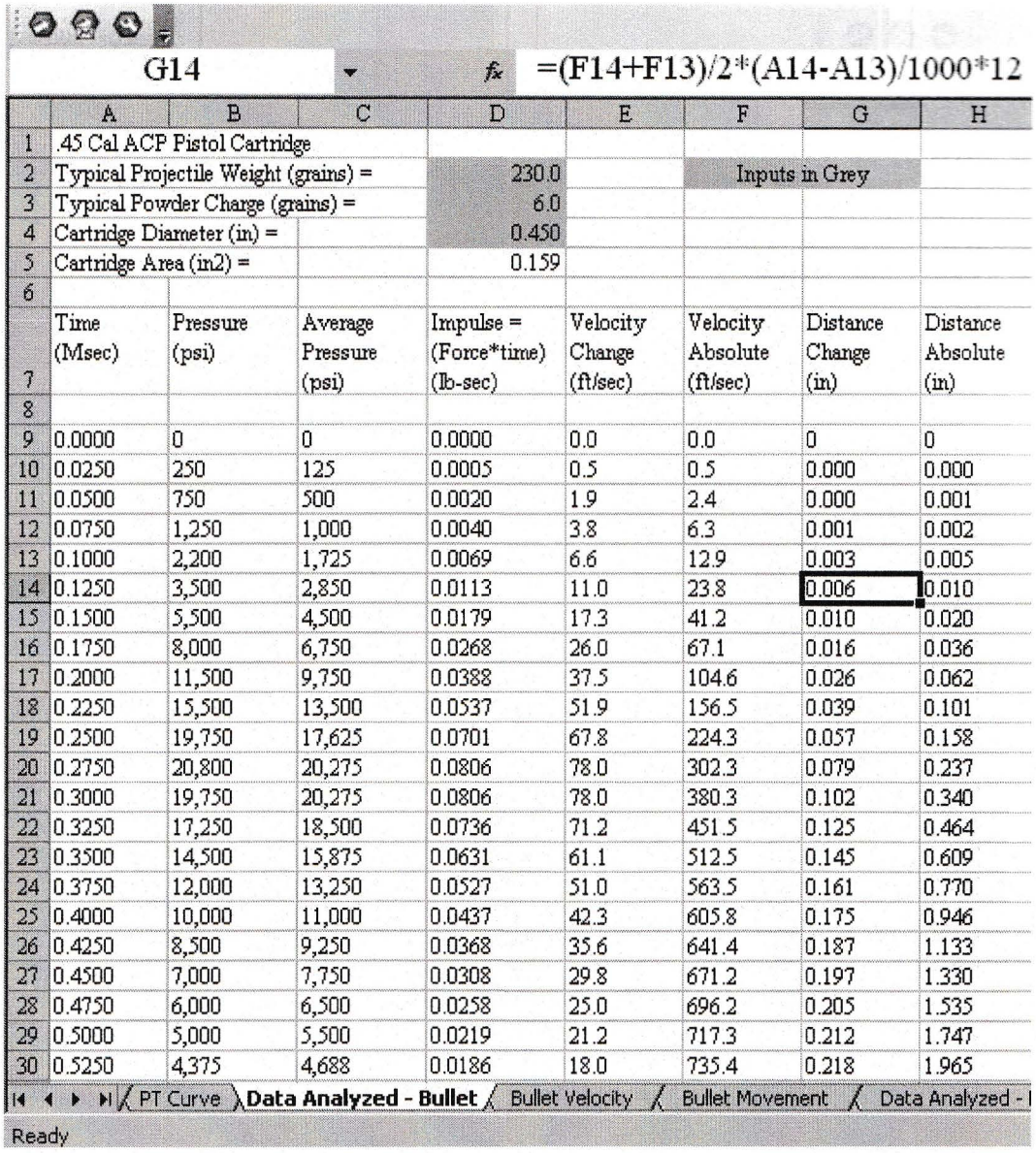


F14 =F13+E14

	A	B	C	D	E	F	G	H
1	.45 Cal ACP Pistol Cartridge							
2	Typical Projectile Weight (grains) =			230.0		Inputs in Grey		
3	Typical Powder Charge (grains) =			6.0				
4	Cartridge Diameter (in) =			0.450				
5	Cartridge Area (in2) =			0.159				
6								
7	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Velocity Change (ft/sec)	Velocity Absolute (ft/sec)	Distance Change (in)	Distance Absolute (in)
8								
9	0.0000	0	0	0.0000	0.0	0.0	0	0
10	0.0250	250	125	0.0005	0.5	0.5	0.000	0.000
11	0.0500	750	500	0.0020	1.9	2.4	0.000	0.001
12	0.0750	1,250	1,000	0.0040	3.8	6.3	0.001	0.002
13	0.1000	2,200	1,725	0.0069	6.6	12.9	0.003	0.005
14	0.1250	3,500	2,850	0.0113	11.0	23.8	0.006	0.010
15	0.1500	5,500	4,500	0.0179	17.3	41.2	0.010	0.020
16	0.1750	8,000	6,750	0.0268	26.0	67.1	0.016	0.036
17	0.2000	11,500	9,750	0.0388	37.5	104.6	0.026	0.062
18	0.2250	15,500	13,500	0.0537	51.9	156.5	0.039	0.101
19	0.2500	19,750	17,625	0.0701	67.8	224.3	0.057	0.158
20	0.2750	20,800	20,275	0.0806	78.0	302.3	0.079	0.237
21	0.3000	19,750	20,275	0.0806	78.0	380.3	0.102	0.340
22	0.3250	17,250	18,500	0.0736	71.2	451.5	0.125	0.464
23	0.3500	14,500	15,875	0.0631	61.1	512.5	0.145	0.609
24	0.3750	12,000	13,250	0.0527	51.0	563.5	0.161	0.770
25	0.4000	10,000	11,000	0.0437	42.3	605.8	0.175	0.946
26	0.4250	8,500	9,250	0.0368	35.6	641.4	0.187	1.133
27	0.4500	7,000	7,750	0.0308	29.8	671.2	0.197	1.330
28	0.4750	6,000	6,500	0.0258	25.0	696.2	0.205	1.535
29	0.5000	5,000	5,500	0.0219	21.2	717.3	0.212	1.747
30	0.5250	4,375	4,688	0.0186	18.0	735.4	0.218	1.965

PT Curve | Data Analyzed - Bullet | Bullet Velocity | Bullet Movement | Data Analyzed -

Ready

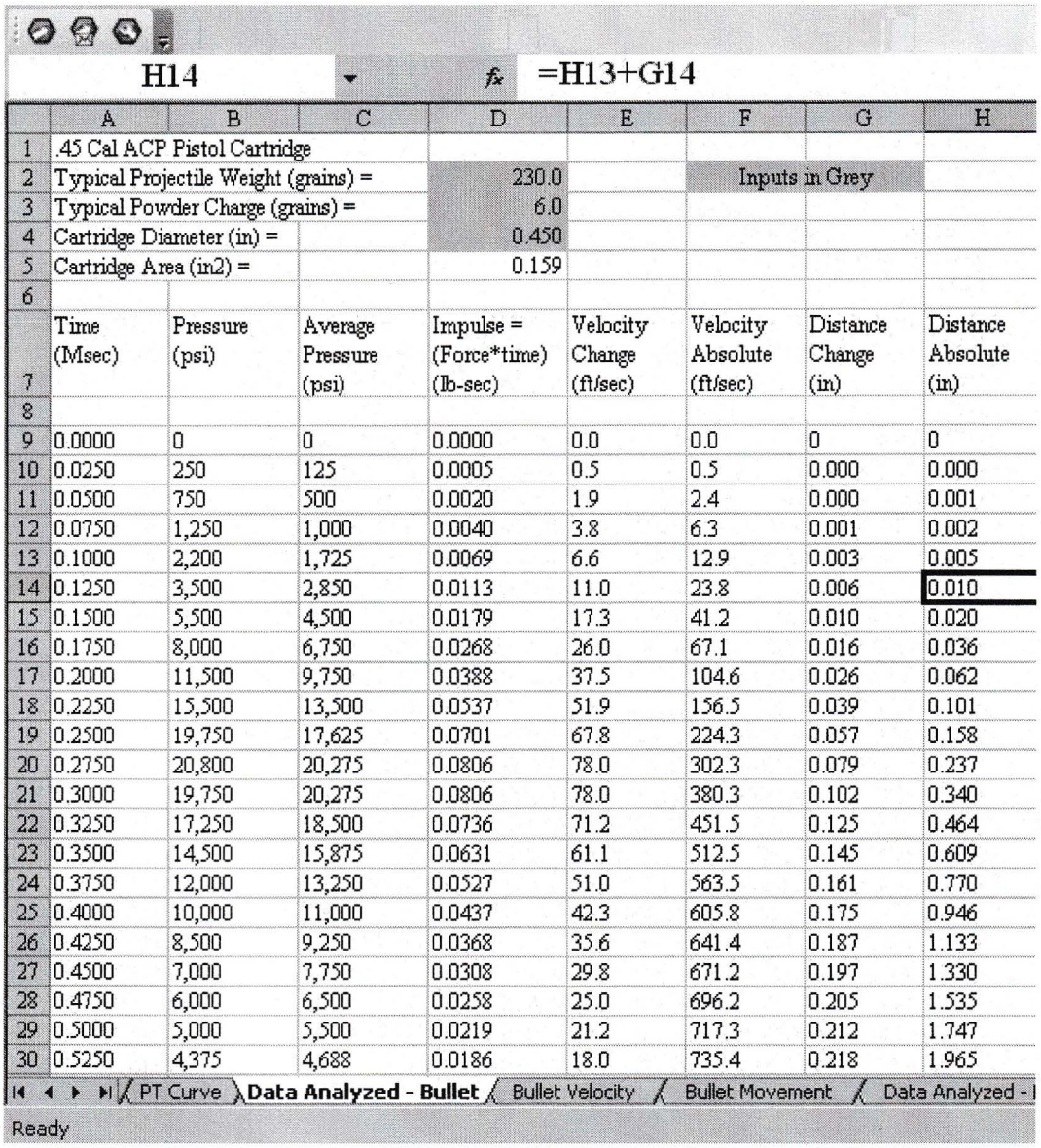


G14 =(F14+F13)/2*(A14-A13)/1000*12

	A	B	C	D	E	F	G	H
1	.45 Cal ACP Pistol Cartridge							
2	Typical Projectile Weight (grains) =			230.0		Inputs in Grey		
3	Typical Powder Charge (grains) =			6.0				
4	Cartridge Diameter (in) =			0.450				
5	Cartridge Area (in2) =			0.159				
6								
7	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Velocity Change (ft/sec)	Velocity Absolute (ft/sec)	Distance Change (in)	Distance Absolute (in)
8								
9	0.0000	0	0	0.0000	0.0	0.0	0	0
10	0.0250	250	125	0.0005	0.5	0.5	0.000	0.000
11	0.0500	750	500	0.0020	1.9	2.4	0.000	0.001
12	0.0750	1,250	1,000	0.0040	3.8	6.3	0.001	0.002
13	0.1000	2,200	1,725	0.0069	6.6	12.9	0.003	0.005
14	0.1250	3,500	2,850	0.0113	11.0	23.8	0.006	0.010
15	0.1500	5,500	4,500	0.0179	17.3	41.2	0.010	0.020
16	0.1750	8,000	6,750	0.0268	26.0	67.1	0.016	0.036
17	0.2000	11,500	9,750	0.0388	37.5	104.6	0.026	0.062
18	0.2250	15,500	13,500	0.0537	51.9	156.5	0.039	0.101
19	0.2500	19,750	17,625	0.0701	67.8	224.3	0.057	0.158
20	0.2750	20,800	20,275	0.0806	78.0	302.3	0.079	0.237
21	0.3000	19,750	20,275	0.0806	78.0	380.3	0.102	0.340
22	0.3250	17,250	18,500	0.0736	71.2	451.5	0.125	0.464
23	0.3500	14,500	15,875	0.0631	61.1	512.5	0.145	0.609
24	0.3750	12,000	13,250	0.0527	51.0	563.5	0.161	0.770
25	0.4000	10,000	11,000	0.0437	42.3	605.8	0.175	0.946
26	0.4250	8,500	9,250	0.0368	35.6	641.4	0.187	1.133
27	0.4500	7,000	7,750	0.0308	29.8	671.2	0.197	1.330
28	0.4750	6,000	6,500	0.0258	25.0	696.2	0.205	1.535
29	0.5000	5,000	5,500	0.0219	21.2	717.3	0.212	1.747
30	0.5250	4,375	4,688	0.0186	18.0	735.4	0.218	1.965

PT Curve | Data Analyzed - Bullet | Bullet Velocity | Bullet Movement | Data Analyzed -

Ready

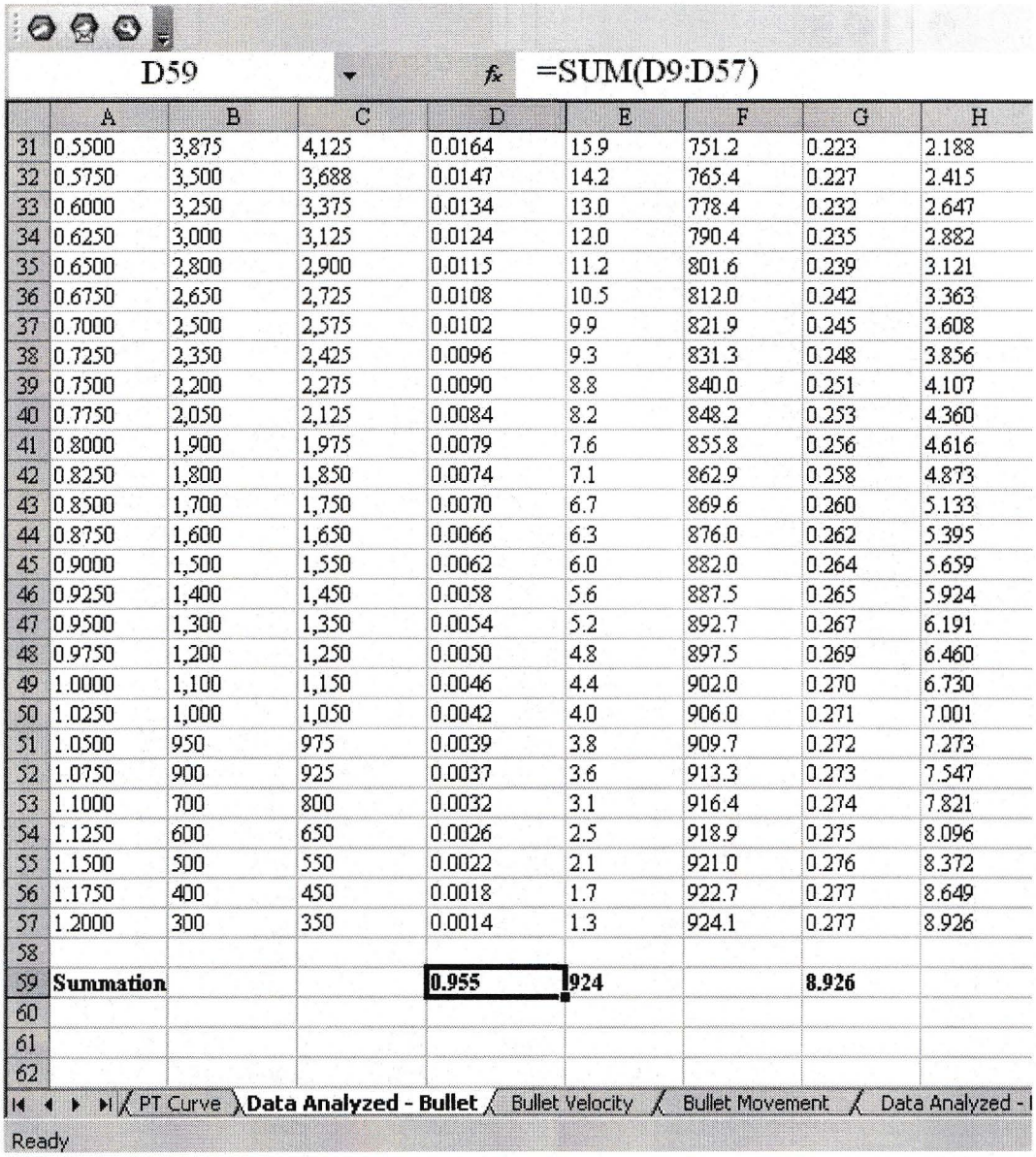


H14 =H13+G14

	A	B	C	D	E	F	G	H
1	.45 Cal ACP Pistol Cartridge							
2	Typical Projectile Weight (grains) =			230.0		Inputs in Grey		
3	Typical Powder Charge (grains) =			6.0				
4	Cartridge Diameter (in) =			0.450				
5	Cartridge Area (in2) =			0.159				
6								
7	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Velocity Change (ft/sec)	Velocity Absolute (ft/sec)	Distance Change (in)	Distance Absolute (in)
8								
9	0.0000	0	0	0.0000	0.0	0.0	0	0
10	0.0250	250	125	0.0005	0.5	0.5	0.000	0.000
11	0.0500	750	500	0.0020	1.9	2.4	0.000	0.001
12	0.0750	1,250	1,000	0.0040	3.8	6.3	0.001	0.002
13	0.1000	2,200	1,725	0.0069	6.6	12.9	0.003	0.005
14	0.1250	3,500	2,850	0.0113	11.0	23.8	0.006	0.010
15	0.1500	5,500	4,500	0.0179	17.3	41.2	0.010	0.020
16	0.1750	8,000	6,750	0.0268	26.0	67.1	0.016	0.036
17	0.2000	11,500	9,750	0.0388	37.5	104.6	0.026	0.062
18	0.2250	15,500	13,500	0.0537	51.9	156.5	0.039	0.101
19	0.2500	19,750	17,625	0.0701	67.8	224.3	0.057	0.158
20	0.2750	20,800	20,275	0.0806	78.0	302.3	0.079	0.237
21	0.3000	19,750	20,275	0.0806	78.0	380.3	0.102	0.340
22	0.3250	17,250	18,500	0.0736	71.2	451.5	0.125	0.464
23	0.3500	14,500	15,875	0.0631	61.1	512.5	0.145	0.609
24	0.3750	12,000	13,250	0.0527	51.0	563.5	0.161	0.770
25	0.4000	10,000	11,000	0.0437	42.3	605.8	0.175	0.946
26	0.4250	8,500	9,250	0.0368	35.6	641.4	0.187	1.133
27	0.4500	7,000	7,750	0.0308	29.8	671.2	0.197	1.330
28	0.4750	6,000	6,500	0.0258	25.0	696.2	0.205	1.535
29	0.5000	5,000	5,500	0.0219	21.2	717.3	0.212	1.747
30	0.5250	4,375	4,688	0.0186	18.0	735.4	0.218	1.965

PT Curve | Data Analyzed - Bullet | Bullet Velocity | Bullet Movement | Data Analyzed -

Ready

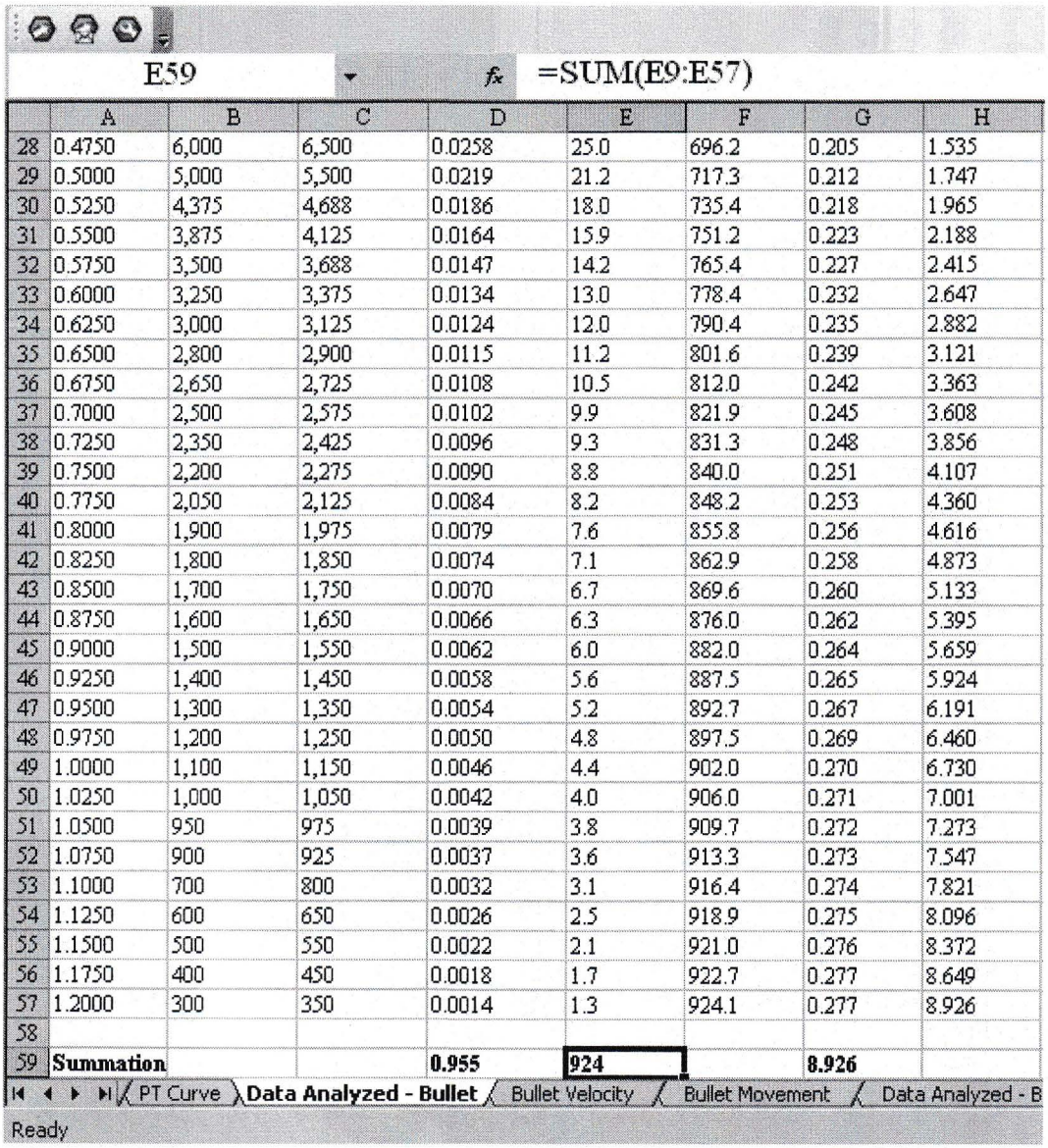


D59 =SUM(D9:D57)

	A	B	C	D	E	F	G	H
31	0.5500	3,875	4,125	0.0164	15.9	751.2	0.223	2.188
32	0.5750	3,500	3,688	0.0147	14.2	765.4	0.227	2.415
33	0.6000	3,250	3,375	0.0134	13.0	778.4	0.232	2.647
34	0.6250	3,000	3,125	0.0124	12.0	790.4	0.235	2.882
35	0.6500	2,800	2,900	0.0115	11.2	801.6	0.239	3.121
36	0.6750	2,650	2,725	0.0108	10.5	812.0	0.242	3.363
37	0.7000	2,500	2,575	0.0102	9.9	821.9	0.245	3.608
38	0.7250	2,350	2,425	0.0096	9.3	831.3	0.248	3.856
39	0.7500	2,200	2,275	0.0090	8.8	840.0	0.251	4.107
40	0.7750	2,050	2,125	0.0084	8.2	848.2	0.253	4.360
41	0.8000	1,900	1,975	0.0079	7.6	855.8	0.256	4.616
42	0.8250	1,800	1,850	0.0074	7.1	862.9	0.258	4.873
43	0.8500	1,700	1,750	0.0070	6.7	869.6	0.260	5.133
44	0.8750	1,600	1,650	0.0066	6.3	876.0	0.262	5.395
45	0.9000	1,500	1,550	0.0062	6.0	882.0	0.264	5.659
46	0.9250	1,400	1,450	0.0058	5.6	887.5	0.265	5.924
47	0.9500	1,300	1,350	0.0054	5.2	892.7	0.267	6.191
48	0.9750	1,200	1,250	0.0050	4.8	897.5	0.269	6.460
49	1.0000	1,100	1,150	0.0046	4.4	902.0	0.270	6.730
50	1.0250	1,000	1,050	0.0042	4.0	906.0	0.271	7.001
51	1.0500	950	975	0.0039	3.8	909.7	0.272	7.273
52	1.0750	900	925	0.0037	3.6	913.3	0.273	7.547
53	1.1000	700	800	0.0032	3.1	916.4	0.274	7.821
54	1.1250	600	650	0.0026	2.5	918.9	0.275	8.096
55	1.1500	500	550	0.0022	2.1	921.0	0.276	8.372
56	1.1750	400	450	0.0018	1.7	922.7	0.277	8.649
57	1.2000	300	350	0.0014	1.3	924.1	0.277	8.926
58								
59	**Summation**			**0.955**	**924**		**8.926**	
60								
61								
62								

PT Curve | **Data Analyzed - Bullet** | Bullet Velocity | Bullet Movement | Data Analyzed -

Ready



E59 =SUM(E9:E57)

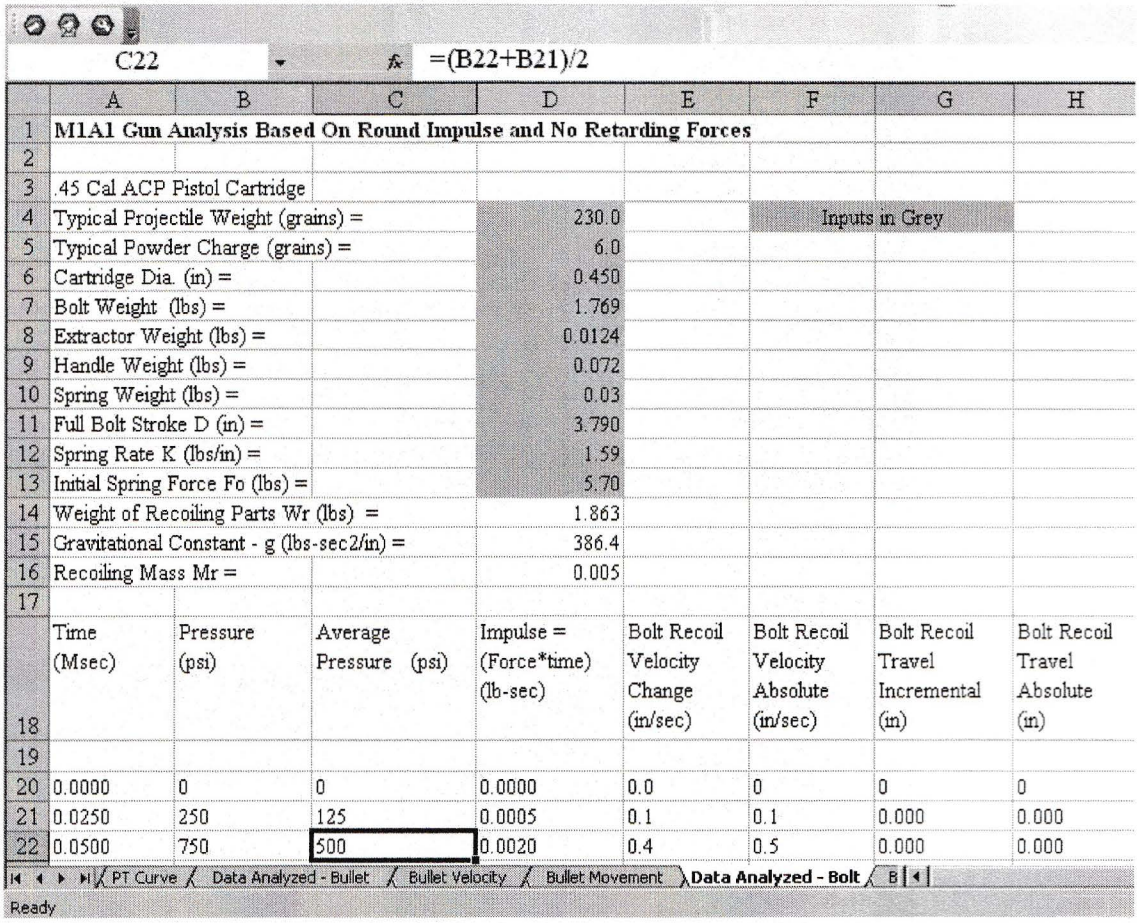
	A	B	C	D	E	F	G	H
28	0.4750	6,000	6,500	0.0258	25.0	696.2	0.205	1.535
29	0.5000	5,000	5,500	0.0219	21.2	717.3	0.212	1.747
30	0.5250	4,375	4,688	0.0186	18.0	735.4	0.218	1.965
31	0.5500	3,875	4,125	0.0164	15.9	751.2	0.223	2.188
32	0.5750	3,500	3,688	0.0147	14.2	765.4	0.227	2.415
33	0.6000	3,250	3,375	0.0134	13.0	778.4	0.232	2.647
34	0.6250	3,000	3,125	0.0124	12.0	790.4	0.235	2.882
35	0.6500	2,800	2,900	0.0115	11.2	801.6	0.239	3.121
36	0.6750	2,650	2,725	0.0108	10.5	812.0	0.242	3.363
37	0.7000	2,500	2,575	0.0102	9.9	821.9	0.245	3.608
38	0.7250	2,350	2,425	0.0096	9.3	831.3	0.248	3.856
39	0.7500	2,200	2,275	0.0090	8.8	840.0	0.251	4.107
40	0.7750	2,050	2,125	0.0084	8.2	848.2	0.253	4.360
41	0.8000	1,900	1,975	0.0079	7.6	855.8	0.256	4.616
42	0.8250	1,800	1,850	0.0074	7.1	862.9	0.258	4.873
43	0.8500	1,700	1,750	0.0070	6.7	869.6	0.260	5.133
44	0.8750	1,600	1,650	0.0066	6.3	876.0	0.262	5.395
45	0.9000	1,500	1,550	0.0062	6.0	882.0	0.264	5.659
46	0.9250	1,400	1,450	0.0058	5.6	887.5	0.265	5.924
47	0.9500	1,300	1,350	0.0054	5.2	892.7	0.267	6.191
48	0.9750	1,200	1,250	0.0050	4.8	897.5	0.269	6.460
49	1.0000	1,100	1,150	0.0046	4.4	902.0	0.270	6.730
50	1.0250	1,000	1,050	0.0042	4.0	906.0	0.271	7.001
51	1.0500	950	975	0.0039	3.8	909.7	0.272	7.273
52	1.0750	900	925	0.0037	3.6	913.3	0.273	7.547
53	1.1000	700	800	0.0032	3.1	916.4	0.274	7.821
54	1.1250	600	650	0.0026	2.5	918.9	0.275	8.096
55	1.1500	500	550	0.0022	2.1	921.0	0.276	8.372
56	1.1750	400	450	0.0018	1.7	922.7	0.277	8.649
57	1.2000	300	350	0.0014	1.3	924.1	0.277	8.926
58								
59	**Summation**			**0.955**	**924**		**8.926**	

PT Curve | **Data Analyzed - Bullet** | Bullet Velocity | Bullet Movement | Data Analyzed - B

Ready

Appendix III
Excel Screen Shots for Determining Firearm Round Per Minute Level

The following screen shots will assist you set up your own Excel spreadsheet for analyzing the rpm level of a blowback firearm assuming no frictional forces as in Chapter II.



C22 =(B22+B21)/2

	A	B	C	D	E	F	G	H
1	**M1A1 Gun Analysis Based On Round Impulse and No Retarding Forces**							
2								
3	.45 Cal ACP Pistol Cartridge							
4	Typical Projectile Weight (grains) =			230.0		Inputs in Grey		
5	Typical Powder Charge (grains) =			6.0				
6	Cartridge Dia. (in) =			0.450				
7	Bolt Weight (lbs) =			1.769				
8	Extractor Weight (lbs) =			0.0124				
9	Handle Weight (lbs) =			0.072				
10	Spring Weight (lbs) =			0.03				
11	Full Bolt Stroke D (in) =			3.790				
12	Spring Rate K (lbs/in) =			1.59				
13	Initial Spring Force Fo (lbs) =			5.70				
14	Weight of Recoiling Parts Wr (lbs) =			1.863				
15	Gravitational Constant - g (lbs-sec2/in) =			386.4				
16	Recoiling Mass Mr =			0.005				
17								
18	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Bolt Recoil Velocity Change (in/sec)	Bolt Recoil Velocity Absolute (in/sec)	Bolt Recoil Travel Incremental (in)	Bolt Recoil Travel Absolute (in)
19								
20	0.0000	0	0	0.0000	0.0	0	0	0
21	0.0250	250	125	0.0005	0.1	0.1	0.000	0.000
22	0.0500	750	500	0.0020	0.4	0.5	0.000	0.000

PT Curve | Data Analyzed - Bullet | Bullet Velocity | Bullet Movement | Data Analyzed - Bolt | B

Ready

D22 =(C22*(A22-A21)/1000*3.1415*POWER($D$6/2,2))

	A	B	C	D	E	F	G	H
1	**M1A1 Gun Analysis Based On Round Impulse and No Retarding Forces**							
2								
3	.45 Cal ACP Pistol Cartridge							
4	Typical Projectile Weight (grains) =			230.0		Inputs in Grey		
5	Typical Powder Charge (grains) =			6.0				
6	Cartridge Dia. (in) =			0.450				
7	Bolt Weight (lbs) =			1.769				
8	Extractor Weight (lbs) =			0.0124				
9	Handle Weight (lbs) =			0.072				
10	Spring Weight (lbs) =			0.03				
11	Full Bolt Stroke D (in) =			3.790				
12	Spring Rate K (lbs/in) =			1.59				
13	Initial Spring Force Fo (lbs) =			5.70				
14	Weight of Recoiling Parts Wr (lbs) =			1.863				
15	Gravitational Constant - g (lbs-sec2/in) =			386.4				
16	Recoiling Mass Mr =			0.005				
17								
18	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Bolt Recoil Velocity Change (in/sec)	Bolt Recoil Velocity Absolute (in/sec)	Bolt Recoil Travel Incremental (in)	Bolt Recoil Travel Absolute (in)
19								
20	0.0000	0	0	0.0000	0.0	0	0	0
21	0.0250	250	125	0.0005	0.1	0.1	0.000	0.000
22	0.0500	750	500	0.0020	0.4	0.5	0.000	0.000

PT Curve | Data Analyzed - Bullet | Bullet Velocity | Bullet Movement | **Data Analyzed - Bolt** | B

Ready

E22 =D22*($D$15/$D$14)

	A	B	C	D	E	F	G	H
1	**M1A1 Gun Analysis Based On Round Impulse and No Retarding Forces**							
2								
3	.45 Cal ACP Pistol Cartridge							
4	Typical Projectile Weight (grains) =			230.0		Inputs in Grey		
5	Typical Powder Charge (grains) =			6.0				
6	Cartridge Dia. (in) =			0.450				
7	Bolt Weight (lbs) =			1.769				
8	Extractor Weight (lbs) =			0.0124				
9	Handle Weight (lbs) =			0.072				
10	Spring Weight (lbs) =			0.03				
11	Full Bolt Stroke D (in) =			3.790				
12	Spring Rate K (lbs/in) =			1.59				
13	Initial Spring Force Fo (lbs) =			5.70				
14	Weight of Recoiling Parts Wr (lbs) =			1.863				
15	Gravitational Constant - g (lbs-sec2/in) =			386.4				
16	Recoiling Mass Mr =			0.005				
17								
18	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Bolt Recoil Velocity Change (in/sec)	Bolt Recoil Velocity Absolute (in/sec)	Bolt Recoil Travel Incremental (in)	Bolt Recoil Travel Absolute (in)
19								
20	0.0000	0	0	0.0000	0.0	0	0	0
21	0.0250	250	125	0.0005	0.1	0.1	0.000	0.000
22	0.0500	750	500	0.0020	0.4	0.5	0.000	0.000

PT Curve | Data Analyzed - Bullet | Bullet Velocity | Bullet Movement | **Data Analyzed - Bolt** | B

Ready

F22 =F21+E22

	A	B	C	D	E	F	G	H
1	**M1A1 Gun Analysis Based On Round Impulse and No Retarding Forces**							
2								
3	.45 Cal ACP Pistol Cartridge							
4	Typical Projectile Weight (grains) =			230.0		Inputs in Grey		
5	Typical Powder Charge (grains) =			6.0				
6	Cartridge Dia. (in) =			0.450				
7	Bolt Weight (lbs) =			1.769				
8	Extractor Weight (lbs) =			0.0124				
9	Handle Weight (lbs) =			0.072				
10	Spring Weight (lbs) =			0.03				
11	Full Bolt Stroke D (in) =			3.790				
12	Spring Rate K (lbs/in) =			1.59				
13	Initial Spring Force Fo (lbs) =			5.70				
14	Weight of Recoiling Parts Wr (lbs) =			1.863				
15	Gravitational Constant - g (lbs-sec2/in) =			386.4				
16	Recoiling Mass Mr =			0.005				
17								
18	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Bolt Recoil Velocity Change (in/sec)	Bolt Recoil Velocity Absolute (in/sec)	Bolt Recoil Travel Incremental (in)	Bolt Recoil Travel Absolute (in)
19								
20	0.0000	0	0	0.0000	0.0	0	0	0
21	0.0250	250	125	0.0005	0.1	0.1	0.000	0.000
22	0.0500	750	500	0.0020	0.4	0.5	0.000	0.000

PT Curve | Data Analyzed - Bullet | Bullet Velocity | Bullet Movement | Data Analyzed - Bolt | B

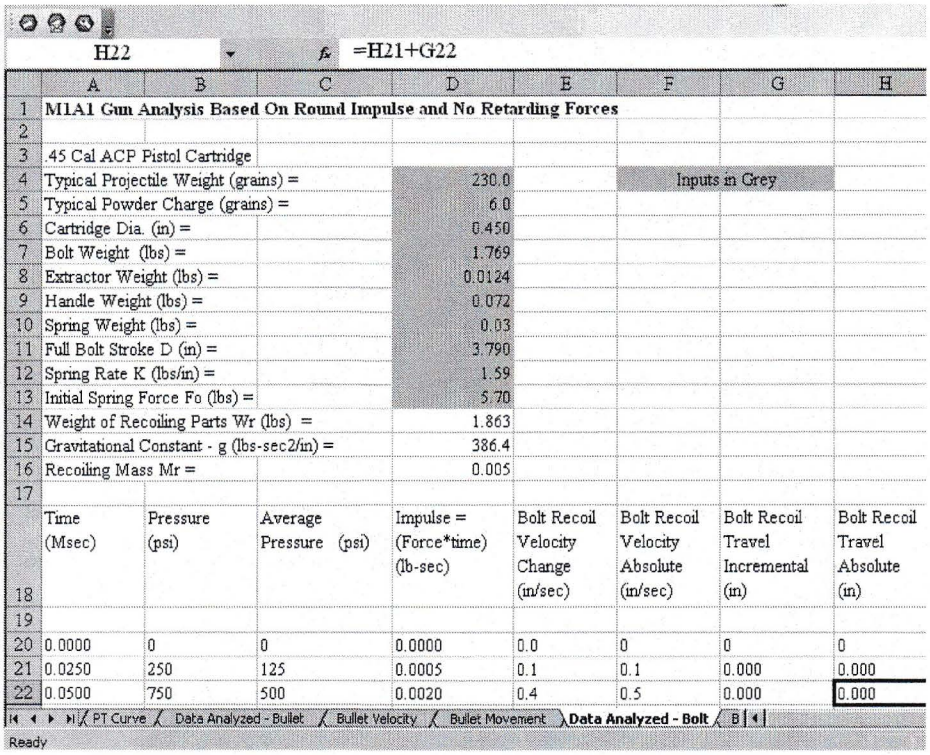
Ready

G22 =(F22+F21)/2*(A22-A21)/1000

	A	B	C	D	E	F	G	H
1	**M1A1 Gun Analysis Based On Round Impulse and No Retarding Forces**							
2								
3	.45 Cal ACP Pistol Cartridge							
4	Typical Projectile Weight (grains) =			230.0		Inputs in Grey		
5	Typical Powder Charge (grains) =			6.0				
6	Cartridge Dia. (in) =			0.450				
7	Bolt Weight (lbs) =			1.769				
8	Extractor Weight (lbs) =			0.0124				
9	Handle Weight (lbs) =			0.072				
10	Spring Weight (lbs) =			0.03				
11	Full Bolt Stroke D (in) =			3.790				
12	Spring Rate K (lbs/in) =			1.59				
13	Initial Spring Force Fo (lbs) =			5.70				
14	Weight of Recoiling Parts Wr (lbs) =			1.863				
15	Gravitational Constant - g (lbs-sec2/in) =			386.4				
16	Recoiling Mass Mr =			0.005				
17								
18	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Bolt Recoil Velocity Change (in/sec)	Bolt Recoil Velocity Absolute (in/sec)	Bolt Recoil Travel Incremental (in)	Bolt Reco Travel Absolute (in)
19								
20	0.0000	0	0	0.0000	0.0	0	0	0
21	0.0250	250	125	0.0005	0.1	0.1	0.000	0.000
22	0.0500	750	500	0.0020	0.4	0.5	0.000	0.000

PT Curve | Data Analyzed - Bullet | Bullet Velocity | Bullet Movement | Data Analyzed - Bolt | B

Ready

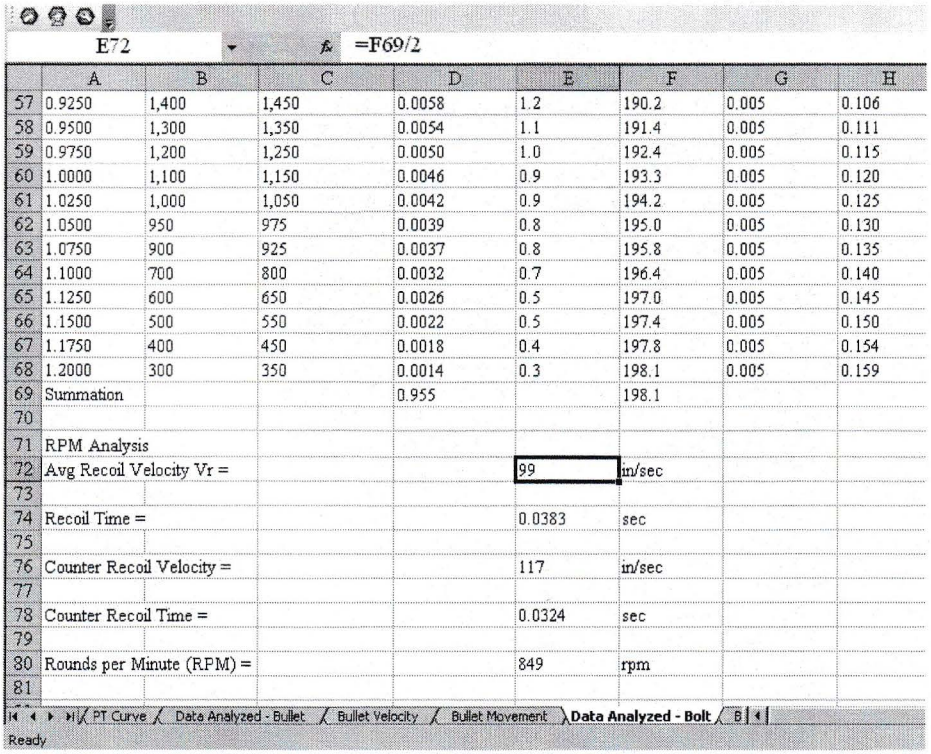


H22 =H21+G22

	A	B	C	D	E	F	G	H
1	**M1A1 Gun Analysis Based On Round Impulse and No Retarding Forces**							
2								
3	.45 Cal ACP Pistol Cartridge							
4	Typical Projectile Weight (grains) =			230.0		Inputs in Grey		
5	Typical Powder Charge (grains) =			6.0				
6	Cartridge Dia. (in) =			0.450				
7	Bolt Weight (lbs) =			1.769				
8	Extractor Weight (lbs) =			0.0124				
9	Handle Weight (lbs) =			0.072				
10	Spring Weight (lbs) =			0.03				
11	Full Bolt Stroke D (in) =			3.790				
12	Spring Rate K (lbs/in) =			1.59				
13	Initial Spring Force Fo (lbs) =			5.70				
14	Weight of Recoiling Parts Wr (lbs) =			1.863				
15	Gravitational Constant - g (lbs-sec2/in) =			386.4				
16	Recoiling Mass Mr =			0.005				
17								
18	Time (Msec)	Pressure (psi)	Average Pressure (psi)	Impulse = (Force*time) (lb-sec)	Bolt Recoil Velocity Change (in/sec)	Bolt Recoil Velocity Absolute (in/sec)	Bolt Recoil Travel Incremental (in)	Bolt Recoil Travel Absolute (in)
19								
20	0.0000	0	0	0.0000	0.0	0	0	0
21	0.0250	250	125	0.0005	0.1	0.1	0.000	0.000
22	0.0500	750	500	0.0020	0.4	0.5	0.000	0.000

PT Curve | Data Analyzed - Bullet | Bullet Velocity | Bullet Movement | **Data Analyzed - Bolt** | B

Ready



E72 =F69/2

	A	B	C	D	E	F	G	H
57	0.9250	1,400	1,450	0.0058	1.2	190.2	0.005	0.106
58	0.9500	1,300	1,350	0.0054	1.1	191.4	0.005	0.111
59	0.9750	1,200	1,250	0.0050	1.0	192.4	0.005	0.115
60	1.0000	1,100	1,150	0.0046	0.9	193.3	0.005	0.120
61	1.0250	1,000	1,050	0.0042	0.9	194.2	0.005	0.125
62	1.0500	950	975	0.0039	0.8	195.0	0.005	0.130
63	1.0750	900	925	0.0037	0.8	195.8	0.005	0.135
64	1.1000	700	800	0.0032	0.7	196.4	0.005	0.140
65	1.1250	600	650	0.0026	0.5	197.0	0.005	0.145
66	1.1500	500	550	0.0022	0.5	197.4	0.005	0.150
67	1.1750	400	450	0.0018	0.4	197.8	0.005	0.154
68	1.2000	300	350	0.0014	0.3	198.1	0.005	0.159
69	Summation			0.955		198.1		
70								
71	RPM Analysis							
72	Avg Recoil Velocity Vr =				99	in/sec		
73								
74	Recoil Time =				0.0383	sec		
75								
76	Counter Recoil Velocity =				117	in/sec		
77								
78	Counter Recoil Time =				0.0324	sec		
79								
80	Rounds per Minute (RPM) =				849	rpm		
81								

PT Curve | Data Analyzed - Bullet | Bullet Velocity | Bullet Movement | **Data Analyzed - Bolt** | B

Ready

E74 =D11/E72

	A	B	C	D	E	F	G	H
57	0.9250	1,400	1,450	0.0058	1.2	190.2	0.005	0.106
58	0.9500	1,300	1,350	0.0054	1.1	191.4	0.005	0.111
59	0.9750	1,200	1,250	0.0050	1.0	192.4	0.005	0.115
60	1.0000	1,100	1,150	0.0046	0.9	193.3	0.005	0.120
61	1.0250	1,000	1,050	0.0042	0.9	194.2	0.005	0.125
62	1.0500	950	975	0.0039	0.8	195.0	0.005	0.130
63	1.0750	900	925	0.0037	0.8	195.8	0.005	0.135
64	1.1000	700	800	0.0032	0.7	196.4	0.005	0.140
65	1.1250	600	650	0.0026	0.5	197.0	0.005	0.145
66	1.1500	500	550	0.0022	0.5	197.4	0.005	0.150
67	1.1750	400	450	0.0018	0.4	197.8	0.005	0.154
68	1.2000	300	350	0.0014	0.3	198.1	0.005	0.159
69	Summation			0.955		198.1		
70								
71	RPM Analysis							
72	Avg Recoil Velocity Vr =				99	in/sec		
73								
74	Recoil Time =				0.0383	sec		
75								
76	Counter Recoil Velocity =				117	in/sec		
77								
78	Counter Recoil Time =				0.0324	sec		
79								
80	Rounds per Minute (RPM) =				849	rpm		
81								

PT Curve / Data Analyzed - Bullet / Bullet Velocity / Bullet Movement / **Data Analyzed - Bolt** / B

Ready

E76 =SQRT((2*D13*D11+D12*D11*D11)/D16)

	A	B	C	D	E	F	G	H
57	0.9250	1,400	1,450	0.0058	1.2	190.2	0.005	0.106
58	0.9500	1,300	1,350	0.0054	1.1	191.4	0.005	0.111
59	0.9750	1,200	1,250	0.0050	1.0	192.4	0.005	0.115
60	1.0000	1,100	1,150	0.0046	0.9	193.3	0.005	0.120
61	1.0250	1,000	1,050	0.0042	0.9	194.2	0.005	0.125
62	1.0500	950	975	0.0039	0.8	195.0	0.005	0.130
63	1.0750	900	925	0.0037	0.8	195.8	0.005	0.135
64	1.1000	700	800	0.0032	0.7	196.4	0.005	0.140
65	1.1250	600	650	0.0026	0.5	197.0	0.005	0.145
66	1.1500	500	550	0.0022	0.5	197.4	0.005	0.150
67	1.1750	400	450	0.0018	0.4	197.8	0.005	0.154
68	1.2000	300	350	0.0014	0.3	198.1	0.005	0.159
69	Summation			0.955		198.1		
70								
71	RPM Analysis							
72	Avg Recoil Velocity Vr =				99	in/sec		
73								
74	Recoil Time =				0.0383	sec		
75								
76	Counter Recoil Velocity =				117	in/sec		
77								
78	Counter Recoil Time =				0.0324	sec		
79								
80	Rounds per Minute (RPM) =				849	rpm		
81								

PT Curve / Data Analyzed - Bullet / Bullet Velocity / Bullet Movement / **Data Analyzed - Bolt** / B

Ready

E78 =D11/E76

	A	B	C	D	E	F	G	H
57	0.9250	1,400	1,450	0.0058	1.2	190.2	0.005	0.106
58	0.9500	1,300	1,350	0.0054	1.1	191.4	0.005	0.111
59	0.9750	1,200	1,250	0.0050	1.0	192.4	0.005	0.115
60	1.0000	1,100	1,150	0.0046	0.9	193.3	0.005	0.120
61	1.0250	1,000	1,050	0.0042	0.9	194.2	0.005	0.125
62	1.0500	950	975	0.0039	0.8	195.0	0.005	0.130
63	1.0750	900	925	0.0037	0.8	195.8	0.005	0.135
64	1.1000	700	800	0.0032	0.7	196.4	0.005	0.140
65	1.1250	600	650	0.0026	0.5	197.0	0.005	0.145
66	1.1500	500	550	0.0022	0.5	197.4	0.005	0.150
67	1.1750	400	450	0.0018	0.4	197.8	0.005	0.154
68	1.2000	300	350	0.0014	0.3	198.1	0.005	0.159
69	Summation			0.955		198.1		
70								
71	RPM Analysis							
72	Avg Recoil Velocity Vr =				99	in/sec		
73								
74	Recoil Time =				0.0383	sec		
75								
76	Counter Recoil Velocity =				117	in/sec		
77								
78	Counter Recoil Time =				0.0324	sec		
79								
80	Rounds per Minute (RPM) =				849	rpm		
81								

PT Curve | Data Analyzed - Bullet | Bullet Velocity | Bullet Movement | **Data Analyzed - Bolt** | B

Ready

E80 =60/(E78+E74)

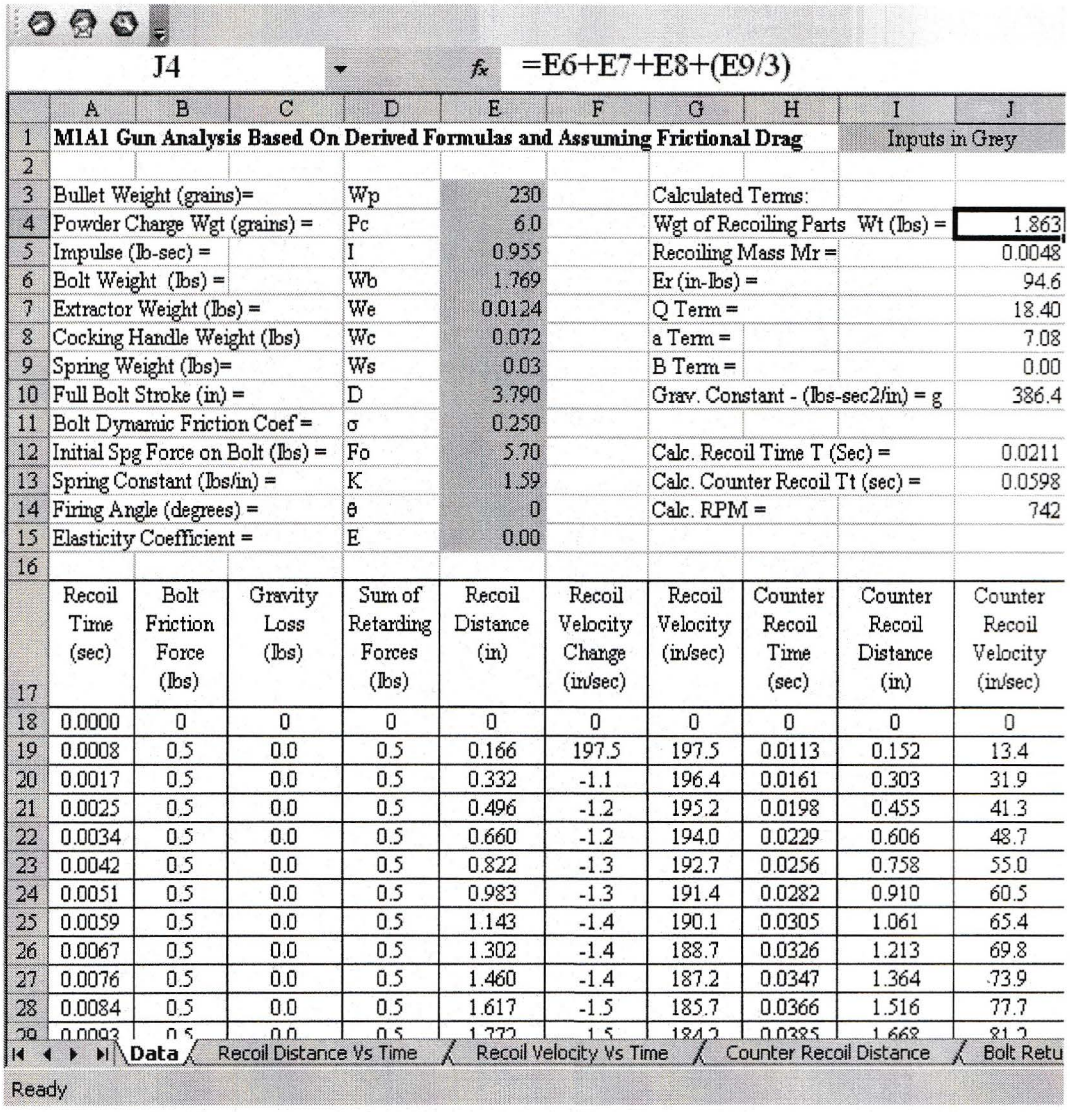
	A	B	C	D	E	F	G	H
57	0.9250	1,400	1,450	0.0058	1.2	190.2	0.005	0.106
58	0.9500	1,300	1,350	0.0054	1.1	191.4	0.005	0.111
59	0.9750	1,200	1,250	0.0050	1.0	192.4	0.005	0.115
60	1.0000	1,100	1,150	0.0046	0.9	193.3	0.005	0.120
61	1.0250	1,000	1,050	0.0042	0.9	194.2	0.005	0.125
62	1.0500	950	975	0.0039	0.8	195.0	0.005	0.130
63	1.0750	900	925	0.0037	0.8	195.8	0.005	0.135
64	1.1000	700	800	0.0032	0.7	196.4	0.005	0.140
65	1.1250	600	650	0.0026	0.5	197.0	0.005	0.145
66	1.1500	500	550	0.0022	0.5	197.4	0.005	0.150
67	1.1750	400	450	0.0018	0.4	197.8	0.005	0.154
68	1.2000	300	350	0.0014	0.3	198.1	0.005	0.159
69	Summation			0.955		198.1		
70								
71	RPM Analysis							
72	Avg Recoil Velocity Vr =				99	in/sec		
73								
74	Recoil Time =				0.0383	sec		
75								
76	Counter Recoil Velocity =				117	in/sec		
77								
78	Counter Recoil Time =				0.0324	sec		
79								
80	Rounds per Minute (RPM) =				849	rpm		
81								

PT Curve | Data Analyzed - Bullet | Bullet Velocity | Bullet Movement | **Data Analyzed - Bolt** | B

Ready

Appendix IV
Excel Screen Shots for Determining Firearm Round Per Minute Level Assuming Frictional Drag and Including Elasticity

The following screen shots will assist you set up your own Excel spreadsheet for determining the functional performance of a blowback firearm assuming frictional drag and including elasticity as in Chapter III.



J4 =E6+E7+E8+(E9/3)

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Retu

Ready

J5 =J4/J10

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Return

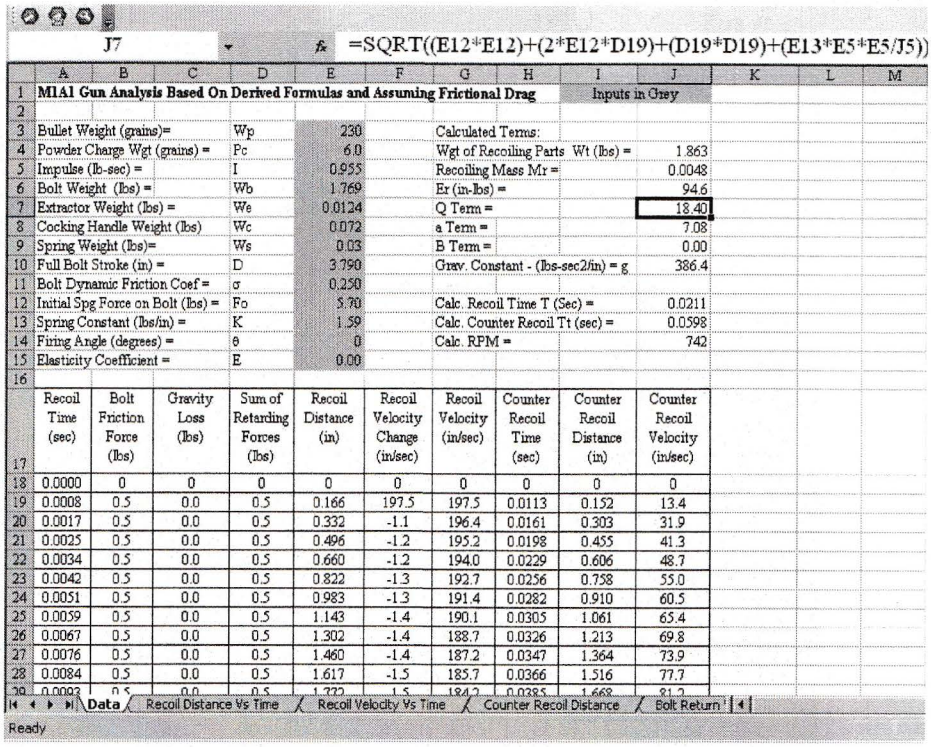
Ready

J6 =POWER(E5,2)*0.5/J5

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Return

Ready



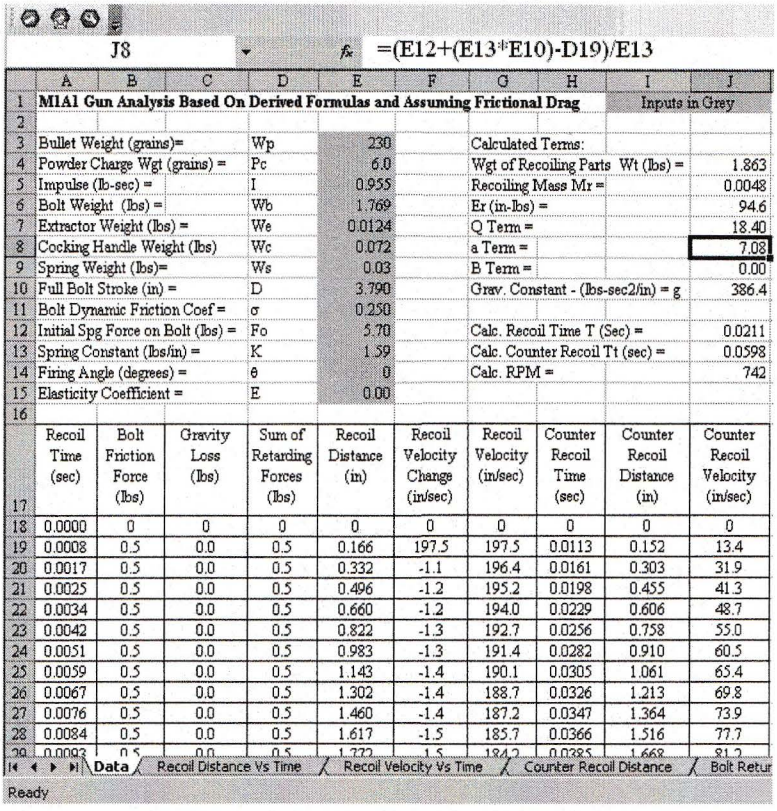
J7 =SQRT((E12*E12)+(2*E12*D19)+(D19*D19)+(E13*E5*E5/J5))

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey				
2													
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:						
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863			
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048			
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6			
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40			
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08			
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00			
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4			
11	Bolt Dynamic Friction Coef =			σ	0.250								
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211			
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598			
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742			
15	Elasticity Coefficient =			E	0.00								
16													

17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Return

Ready



J8 =(E12+(E13*E10)-D19)/E13

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										

17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Retur

Ready

J9 =J5*G43*G43*E15*E15/E13

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										

17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Return

Ready

J12 =SQRT(J5/E13)*(ASIN((E13*E10+E12+D19)/J7)-ASIN((E12+D19)/J7))

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey					
2														
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:							
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863				
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048				
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6				
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40				
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08				
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00				
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4				
11	Bolt Dynamic Friction Coef =			σ	0.250									
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211				
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598				
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742				
15	Elasticity Coefficient =			E	0.00									
16														

17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Return

Ready

J13 =((ATAN((E10-J8)*(SQRT(-1*E10*E10+2*J8*E10+J9)/(E10*E10-2*J8*E10-J9))))-ATAN(J8/J9*SQRT(J9)))*SQRT(J5/E13)*-1

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Return

Ready

J14 =60/(J12+J13)

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Return

Ready

A19 =J12/25

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Return

Ready

B19 =E11*J4*COS(E14*3.1415/180)

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Return

Ready

C19 =J4*SIN(E14*3.1415/180)

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Retur

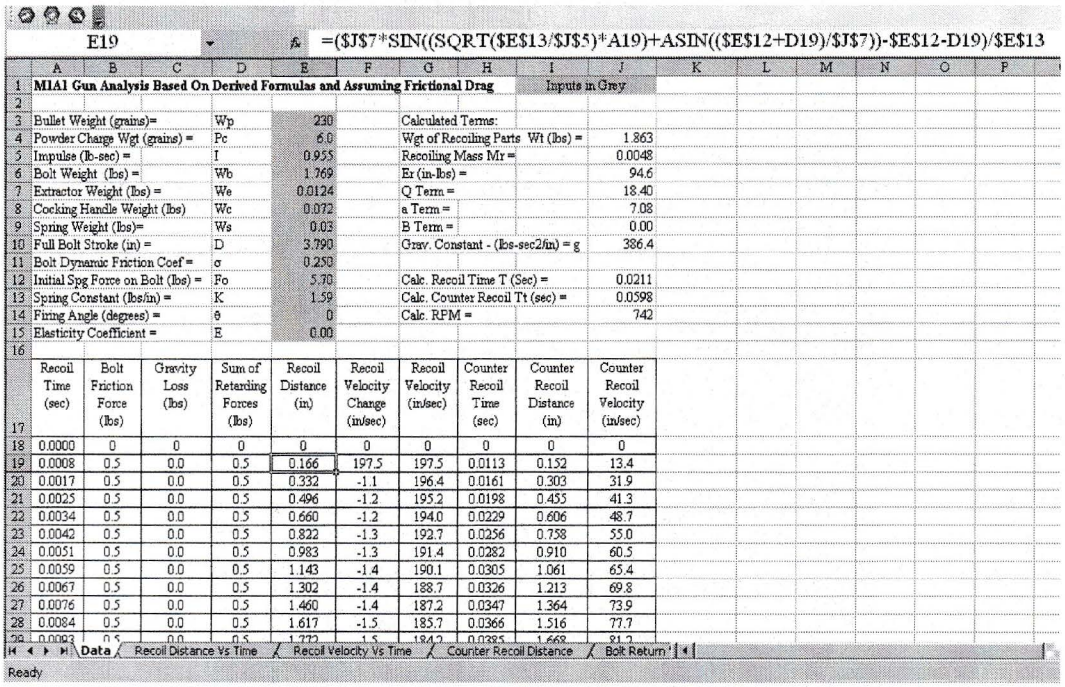
Ready

D19 =SUM(B19:C19)

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Retur

Ready



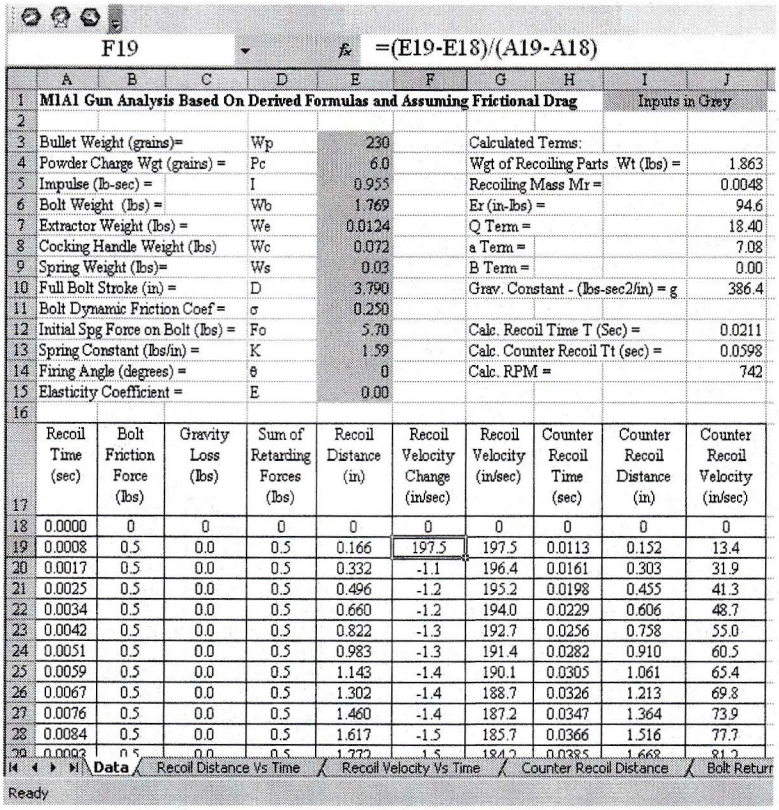
E19 =($J$7*SIN((SQRT($E$13/$J$5)*A19)+ASIN(($E$12+D19)/$J$7))-$E$12-D19)/$E$13

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey							
2																
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:									
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863						
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048						
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6						
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40						
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08						
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00						
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4						
11	Bolt Dynamic Friction Coef =			σ	0.250											
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211						
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598						
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742						
15	Elasticity Coefficient =			E	0.00											
16																

17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Return

Ready



F19 =(E19-E18)/(A19-A18)

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										

17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Return

Ready

G19 =F19+G18

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

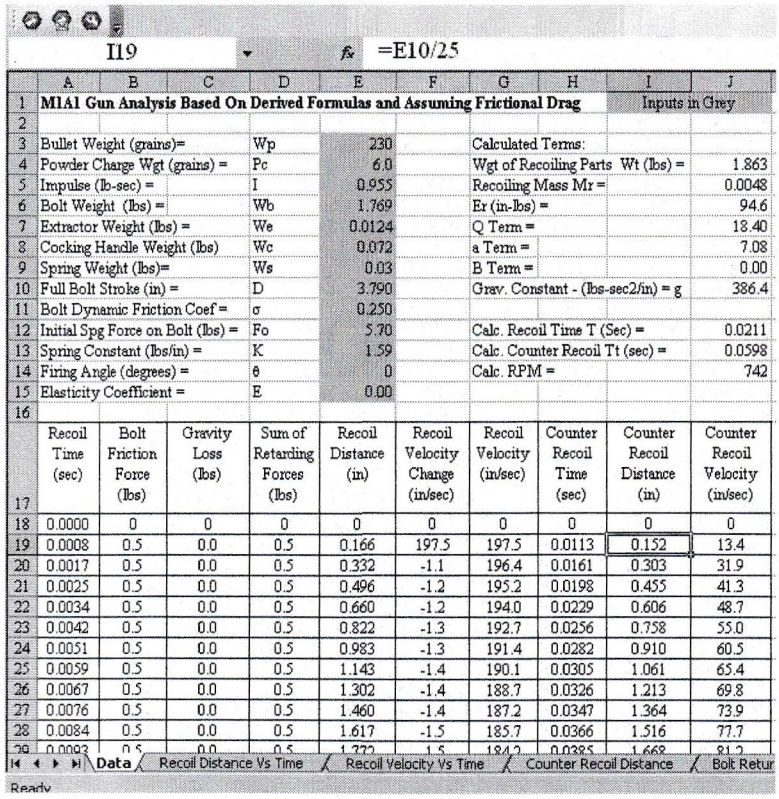
Ready

H19 =((ATAN((I19-$J$8)*(SQRT(-1*I19*I19+2*$J$8*I19+$J$9)/(I19*I19-2*$J$8*I19-$J$9)))))-ATAN($J$8/$J$9*SQRT($J$9)))*SQRT($J$5/$E$13)*-1

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data / Recoil Distance Vs Time / Recoil Velocity Vs Time / Counter Recoil Distance / Bolt Return

Ready

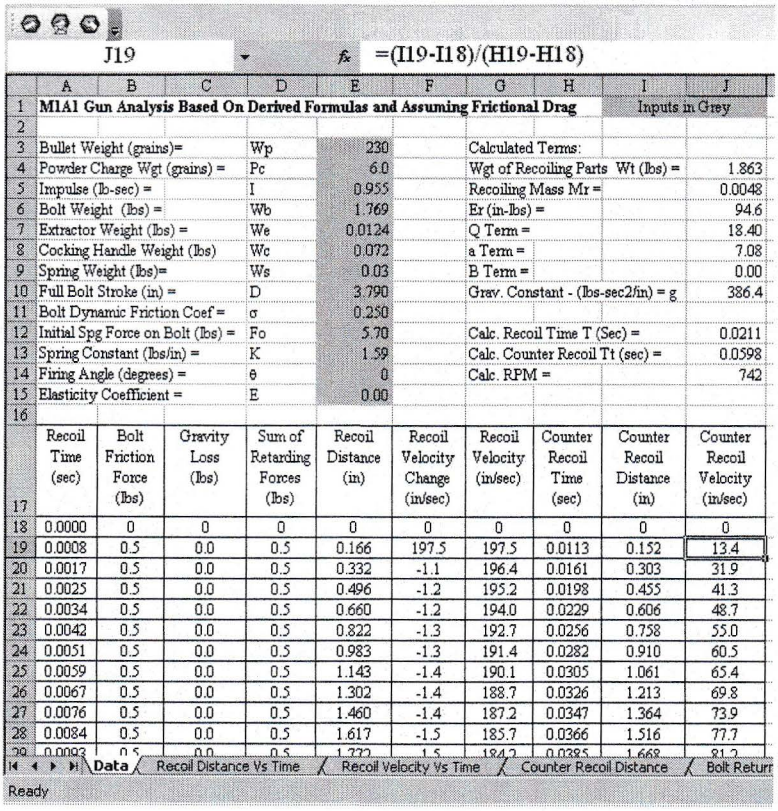


I19 =E10/25

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Retur

Ready

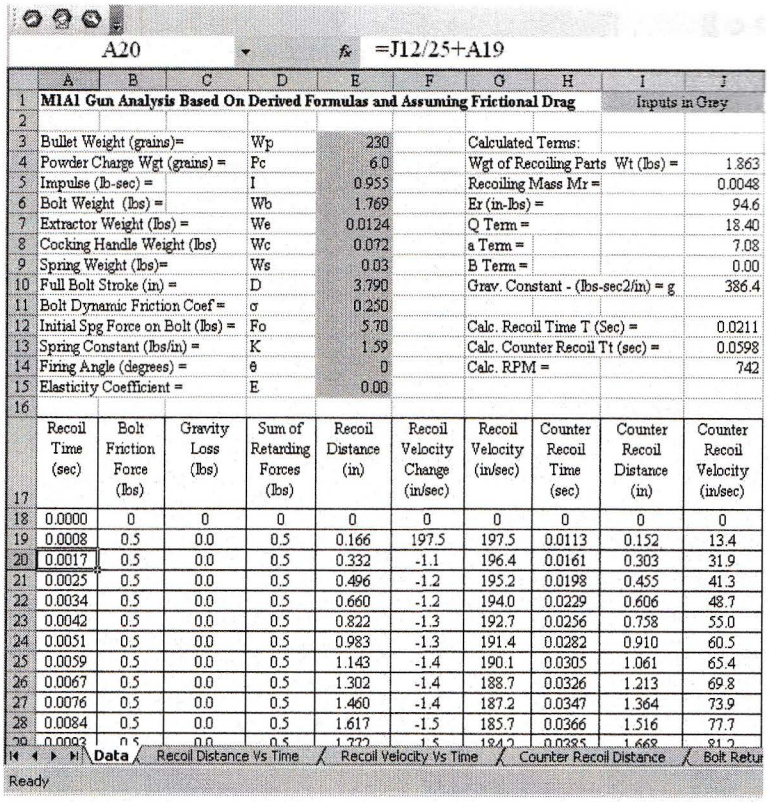


J19 =(I19-I18)/(H19-H18)

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Returr

Ready

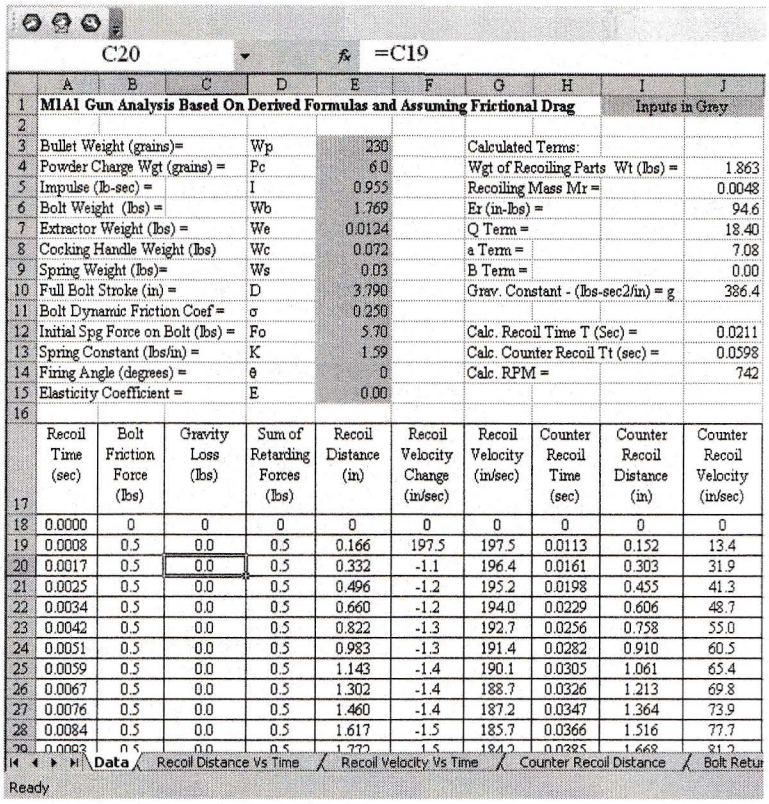


A20 =J12/25+A19

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Retur

Ready



C20 =C19

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Retur

Ready

F20 =(E20-E19)/(A20-A19)-G19

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Return

Ready

H21 =((ATAN((I21-$J$8)*(SQRT(-1*I21*I21+2*$J$8*I21+$J$9)/(I21*I21-2*$J$8*I21-$J$9))))-ATAN($J$8/$J$9*SQRT($J$9)))*SQRT($J$5/$E$13)*-1

	A	B	C	D	E	F	G	H	I	J
1	**M1A1 Gun Analysis Based On Derived Formulas and Assuming Frictional Drag**								Inputs in Grey	
2										
3	Bullet Weight (grains)=			Wp	230		Calculated Terms:			
4	Powder Charge Wgt (grains) =			Pc	6.0		Wgt of Recoiling Parts Wt (lbs) =			1.863
5	Impulse (lb-sec) =			I	0.955		Recoiling Mass Mr =			0.0048
6	Bolt Weight (lbs) =			Wb	1.769		Er (in-lbs) =			94.6
7	Extractor Weight (lbs) =			We	0.0124		Q Term =			18.40
8	Cocking Handle Weight (lbs)			Wc	0.072		a Term =			7.08
9	Spring Weight (lbs)=			Ws	0.03		B Term =			0.00
10	Full Bolt Stroke (in) =			D	3.790		Grav. Constant - (lbs-sec2/in) = g			386.4
11	Bolt Dynamic Friction Coef =			σ	0.250					
12	Initial Spg Force on Bolt (lbs) =			Fo	5.70		Calc. Recoil Time T (Sec) =			0.0211
13	Spring Constant (lbs/in) =			K	1.59		Calc. Counter Recoil Tt (sec) =			0.0598
14	Firing Angle (degrees) =			θ	0		Calc. RPM =			742
15	Elasticity Coefficient =			E	0.00					
16										
17	Recoil Time (sec)	Bolt Friction Force (lbs)	Gravity Loss (lbs)	Sum of Retarding Forces (lbs)	Recoil Distance (in)	Recoil Velocity Change (in/sec)	Recoil Velocity (in/sec)	Counter Recoil Time (sec)	Counter Recoil Distance (in)	Counter Recoil Velocity (in/sec)
18	0.0000	0	0	0	0	0	0	0	0	0
19	0.0008	0.5	0.0	0.5	0.166	197.5	197.5	0.0113	0.152	13.4
20	0.0017	0.5	0.0	0.5	0.332	-1.1	196.4	0.0161	0.303	31.9
21	0.0025	0.5	0.0	0.5	0.496	-1.2	195.2	0.0198	0.455	41.3
22	0.0034	0.5	0.0	0.5	0.660	-1.2	194.0	0.0229	0.606	48.7
23	0.0042	0.5	0.0	0.5	0.822	-1.3	192.7	0.0256	0.758	55.0
24	0.0051	0.5	0.0	0.5	0.983	-1.3	191.4	0.0282	0.910	60.5
25	0.0059	0.5	0.0	0.5	1.143	-1.4	190.1	0.0305	1.061	65.4
26	0.0067	0.5	0.0	0.5	1.302	-1.4	188.7	0.0326	1.213	69.8
27	0.0076	0.5	0.0	0.5	1.460	-1.4	187.2	0.0347	1.364	73.9
28	0.0084	0.5	0.0	0.5	1.617	-1.5	185.7	0.0366	1.516	77.7
29	0.0093	0.5	0.0	0.5	1.772	-1.5	184.2	0.0385	1.668	81.2

Data | Recoil Distance Vs Time | Recoil Velocity Vs Time | Counter Recoil Distance | Bolt Return

Ready

Endnotes

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3. Ibid., 15.

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at www.ICGtesting.com
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This book was written to interest the reader in the simplicity and the hidden complexity that gun designs exhibit and prompt the imagination of the reader to investigate the field of firearms design further. Reading this book will give the reader:

- Three ways to calculate the round per minute(RPM) firing level of a .45 caliber submachine gun using the M1A1 Thompson Submachine gun as the sample firearm.
- Provide two sample computer simulations using Excel to allow the reader to experiment with different .45 caliber sub-machine gun design conditions.
- The full technical data package of a reverse engineered M1A1 Thompson Submachine gun as individual operation process sheets showing the dimensions for each cut.
- The analysis and sample calculations to design an oval magazine spring.
- The explanation, with illustrations, of how the Thompson submachine gun operates.

This book is unique in that it exposes the engineering that goes behind a gun design project.

David Findlay has spent his entire life around firearms and in the field of gun design. His first job was at Remington Arms where he worked for 26 years as a designer and in middle management in charge of other gun designers and firearms acceptance testing. David then worked four years for Marlin Firearms/H&R 1871 as a product engineer and later was in charge of the engineering group at H&R 1871. Currently, he is employed by Smith & Wesson as a product engineer, and holds seven firearms patents.

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